Technical Memorandum –
New I-40/Lone Tree Road Traffic Interchange (MP 196.7)

I-40, Bellemont to Winona

MP 183.0 – MP 214.0

ADOT Project No. 40 CN 183 H7586 01L

Federal Project No. STP-040-C(BBR)

Ash Fork – Flagstaff Highway
Flagstaff – Holbrook Highway

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1.0 Introduction

1.1 Background

The Arizona Department of Transportation (ADOT), in partnership with the Federal Highway Administration (FHWA), has initiated a design concept study and related environmental studies to evaluate proposed improvements to I-40 in Coconino County, Arizona. ADOT Project No. 40 CN 183 H7586 01L [Federal Project Number STP-040-C(BBR)] consists of a study to prepare the design concept for the addition of capacity to Interstate 40 (I-40) from west of the Bellemont traffic interchange (TI) at milepost (MP) 183 to east of the Winona TI at MP 214. This project is located within ADOT's Flagstaff District.

The purpose of this New Lone Tree TI technical memorandum is to present the alternatives and describe the evaluations performed to date. The alternatives have been developed to a conceptual level; as the I-40 study advances, changes to the concepts may be expected.

Lone Tree Road is a major collector road that serves north-south traffic in Flagstaff. It provides access to several schools and residential areas. I-40 crosses above Lone Tree Road via westbound and eastbound mainline bridges. The nearest access points to and from I-40 in this area are provided via the I-17 system interchange to the west (MP 195.5) and the Butler Avenue TI to the east (MP 198.3). Currently, there is no connection between I-40 and Lone Tree Road.

In the early 1990s, Lone Tree Road was formally identified as a potential location for a new TI along I-40 to serve Flagstaff and Northern Arizona University (NAU). The *I-17/I-40 System Interchange Change of Access Report* (ADOT, May 1993) stipulated that the location of the interchange be located far enough away from the system interchange to optimize mainline traffic operations. Realignment of Lone Tree Road approximately 1300 feet west of the existing grade separation was proposed in the 1993 report and also shown in the *Lone Tree Corridor Study* (City of Flagstaff, 2006). The realigned roadway is referred to as "New Lone Tree Road" in this report, with existing Lone Tree Road referred to by its current name, "Lone Tree Road."

The interchange alternatives prepared with the February 2011 I-40 Initial Design Concept Report (DCR) were designed to integrate both the previous planning documents and the recommended I-40 mainline widening improvements. The planned location of New Lone Tree Road is approximately 1800 feet east of the existing grade separation. The Initial DCR recommended widening I-40 to three lanes in each direction to meet capacity needs in the design year 2040.

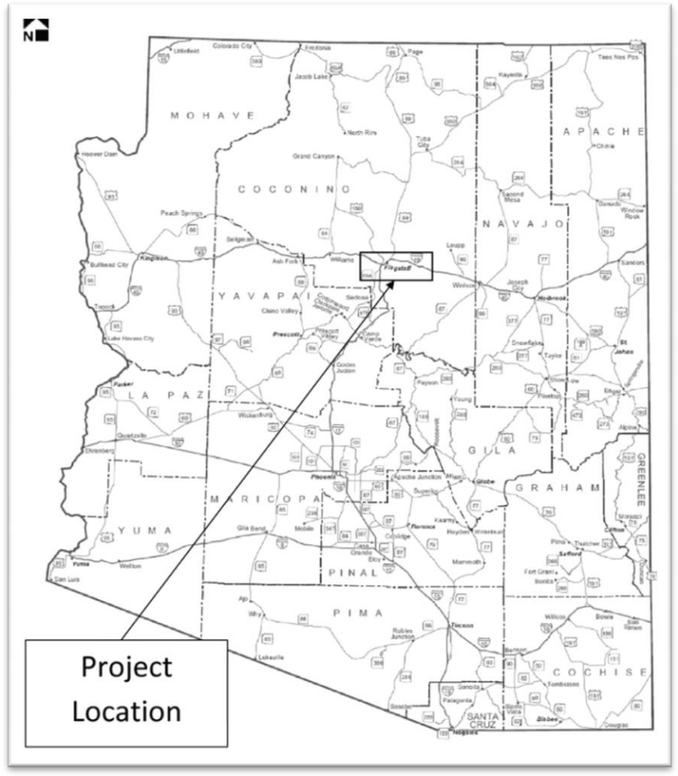
The New Lone Tree Road TI study area encompasses I-40 from approximately the I-40/I-17 system TI to the Rio de Flag bridges (MP 195.5 to MP 197.4). The I-40 Initial DCR recommends widening I-40 to include an additional general purpose lane, an auxiliary lane between interchanges, and wider inside and outside shoulders. The orientation of the crossing of the New Lone Tree, over or under the interstate, is still under evaluation.

The functional classification for I-40 is Fringe-Urban Interstate within the New Lone Tree TI study area. The posted speed limit is 65 miles per hour (mph).

1.2 Description of Project

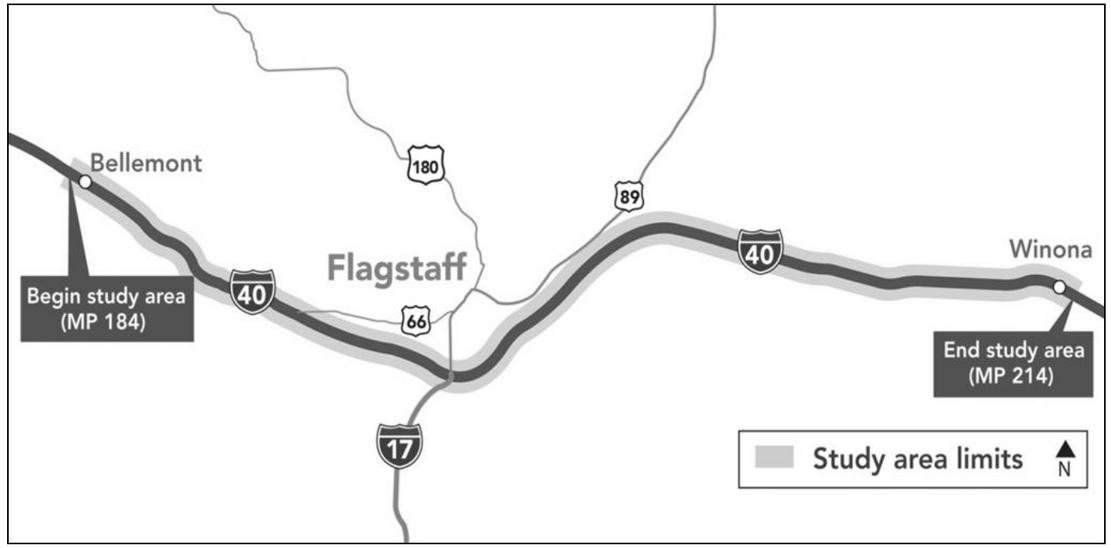
The I-40 study will include a long-range implementation strategy that will guide future decisions regarding interim and ultimate improvements required to meet capacity and operational needs of the traveling public over the next 25-30 years. An Environmental Assessment is being developed in concert with the I-40 design concept study. Implementation of the study recommendations will depend on funding availability and priorities of roadway construction projects.

Figure 1– Vicinity Map



The I-40 DCR and New Lone Tree TI study areas are located in Coconino County and the City of Flagstaff. Figure 1 shows a statewide vicinity map of the project area. Figure 2 reflects the I-40 design concept study area. Figure 3 (Page 3) shows the New Lone Tree TI study area, including the existing I-40/Lone Tree Road grade separation.

Figure 2– I-40 DESIGN CONCEPT STUDY AREA



1.3 Project Objectives

The New Lone Tree Road TI alternatives were designed to accommodate projected traffic volumes for the 2040 design year. Current ADOT and American Association of State Highway and Transportation Officials (AASHTO) design criteria standards were used.

1.4 Existing Conditions

The I-40/I-17 system TI is located at MP 195.5. The Rio de Flag bridges are located at MP 197.43.

This segment of I-40, which provides access to the City of Flagstaff and I-17 to the south, is designated as "urban/ fringe-urban" since it is within the Flagstaff urban boundary. The terrain in the area is generally rolling.

1.4.1 Land Use

The campus of NAU is northwest of the existing grade separation, with the university property extending to I-40 and Lone Tree Road. Coconino Community College is located south of I-40 with its principal access off Lone Tree Road.

An apartment complex, The Ridge at Clear Creek, was recently constructed in the northeast quadrant. The land on the north and south sides of the proposed TI is owned by the Arizona Board of Regents. Private residential developers own land south of I-40 and east of the Coconino Community College property.

1.4.2 Roadway Characteristics

The I-40/I-17 system interchange provides access to Interstate 17 to the south and Milton Road to the north. Mainline lane widths are 12 feet, with 10-foot outside shoulders and 4-foot inside shoulders. The existing highway cross slope is 1.5%. The existing pavement is asphalt.

The existing Lone Tree Road overpass is located at MP 196.26.

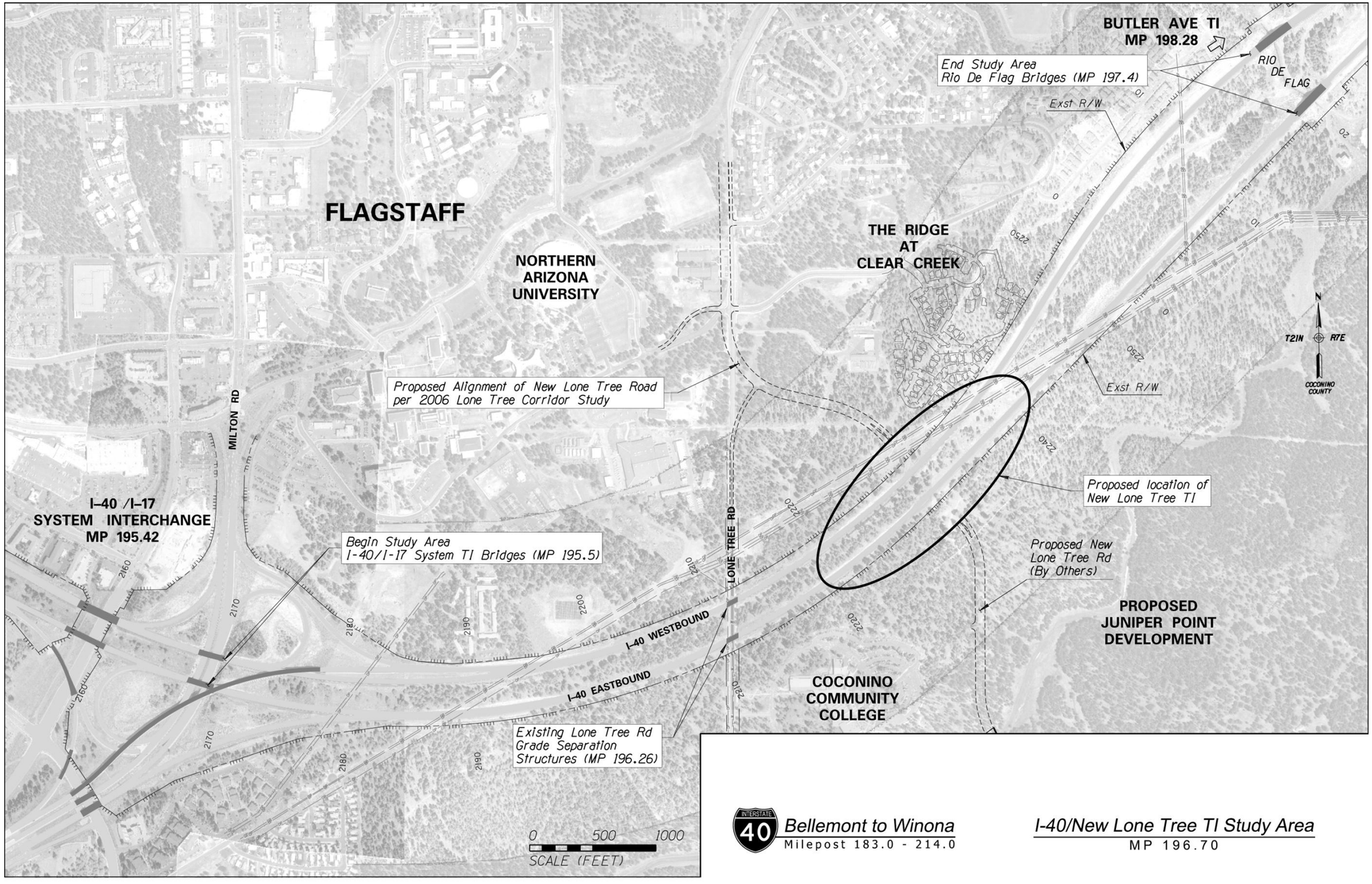
1.4.3 Utilities

The following table lists the major existing utilities which cross I-40 within the New Lone Tree TI study area.

Table 1 – Existing Utilities

UTILITY TYPE	EB/WB	STATION	MILEPOST	LOCATION
Arizona Public Service (APS) (Overhead Power Joint Line)				
OH Power Joint Line Existing	EB/WB	2180+00	195.65	North/south crossing
OH Power Joint Line Existing	EB	2189+00	195.82	North/south crossing
OH Power Joint Line Existing	WB	2194+00	195.92	North/south crossing
OH Power Joint Line Existing	WB	2195+00	195.93	North/south crossing
OH Power Joint Line Existing	EB/WB	2212+00	196.26	North/south crossing
OH Power Joint Line Existing	WB	2235+00	196.69	North/south crossing
OH Power Joint Line Existing	WB	2237+00	196.73	North/south crossing
OH Power Joint Line Existing	WB	2240+00	196.79	North/south crossing
OH Power Joint Line Existing	EB	2246+00	196.90	North/south crossing
OH Power Joint Line Existing	EB	2550+00	197.07	North/south crossing
OH Power Joint Line Existing	EB	5+00	197.16	North/south crossing
OH Power Joint Line Existing	WB	11+00	197.28	North/south crossing
City of Flagstaff (Reclaimed Water)				
Reclaimed Water Existing	EB/WB	2212+00	196.26	North/south crossing, 16" DIP
City of Flagstaff (Sanitary Sewer)				
Sewer	WB	5+00	197.16	North/south crossing
City of Flagstaff (Water Line)				
Water Line Existing	EB/WB	2212+00	196.26	North/south crossing
NPG Cable				
Underground Cable Television Line	EB/WB	2212+00	196.26	North/south crossing
UNISOURCE Gas				
Gas line Existing	EB/WB	2212+00	196.26	North/south crossing, 2" pipe

Figure 3 - Lone Tree TI Study Area



1.4.4 Drainage

Existing Drainage Conditions and Facilities

Storm water generally flows from northwest to the southeast within the New Lone Tree TI study area.

A listing of large box and pipe culverts is shown in Table 2 (source: ADOT topographic mapping and record drawings). Large culverts are defined as having a diameter of 48 inches or larger.

Table 2 – Existing Drainage Facilities

Existing Major Drainage Pipes and Culverts			
MP	**ROADWAY**	**SIZE**	**LENGTH (ft.)**
197.0	EB	54 in. CMP	159
197.1	WB	6x7 ft. CBC	217

CMP = corrugated metal pipe
CBC = concrete box culvert

Within the New Lone Tree TI study area, there are eight smaller drainage pipe crossings in the eastbound direction and eight in the westbound direction. These pipe crossings range from 24 inches to 36 inches in diameter.

1.4.5 Right-of-Way

Existing right-of-way (R/W) widths vary along the I-40 corridor. Table 3 describes the existing right-of-way widths within the New Lone Tree TI study area.

Table 3 – Existing Right-of-Way Widths

BEGIN MP	END MP	APPROXIMATE R/W WIDTH (FEET)	NOTES
195.2	195.8	430-2200	I-40/I-17 system interchange
195.8	196.7	420-460	Lone Tree OP
196.7	198.1	400-900	Rio de Flag bridges

1.4.6 Existing Structures

The existing I-40 bridges in the study area are in good overall structural condition according to the 2008 ADOT Bridge Management Section inspection and maintenance documents. There are a total of two bridges within this study area. The existing structures are listed in Table 4.

Table 4 – Existing Structures

STR NO.	MILEPOST	BUILT	LENGTH (Ft)	WIDTH (Ft)	LOCATION	STRUCTURE TYPE	VERTICAL CLEARANCE (Ft-in)	LAST INSPECTION
1180	196.26	1966	107	37.5	Lone Tree Road OP EB	3-Span Continuous Concrete Slab	15'-6	2008
1181	196.26	1966	107	37.5	Lone Tree Road OP WB	3-Span Continuous Concrete Slab	15'-9	2008

The existing Lone Tree Road OP bridges consist of three-span continuous concrete slab bridges skewed at approximately 27° and constructed in 1966. Both bridges have sufficiency ratings of 91.96 but have been classified as functionally obsolete because of non-conforming lateral and vertical clearances. Lone Tree Road OP under I-40 consists of a two-lane roadway and a paved trail that is part of the Flagstaff Urban Trail System (FUTS).

1.4.7 Geotechnical

Geologic Setting

The lower unit of the Kaibab Formation is called the Fossil Mountain Member, and the upper unit is the Harrisburg Member. The Harrisburg Member is an inter-bedded sequence of light red to gray limestone, dolomite, siltstone, sandstone, and gypsum. The Harrisburg Member of the Kaibab Formation is exposed from 0.25 mile east of the I-40/ I-17 system interchange, at Lone Tree Road, Butler Avenue and the Fourth Street Bridge. From MP 201.95 to MP 202.2, east of the Rio de Flag, the Fossil Mountain Member is exposed in the highway road cuts.

Groundwater/Surface Water Conditions

Within the study limits, perched groundwater conditions are present. Normally shallow aquifers are found close to the surface of unconsolidated alluvium, volcanic rocks and in the interbedded sandstones in the Kaibab Formation. Uncontrolled ingress of moisture during and after construction could lead to construction delays and premature deterioration of embankment fills and pavement distress. The potential impact of perched groundwater should be investigated further during the final geotechnical investigation for this project.

Photo 1. Existing Lone Tree Road, looking north.

Pavement Conditions

The pavement in the segment of I-40 from approximately MP 195 to MP 202 is recommended for complete replacement.

2.0 Traffic Data

2.1 Background

The traffic data for this technical memorandum was originally presented in the March 2010 Preliminary Traffic Report and the February 2011 Initial Design Concept Report. The design year for the study is 2040.

2.2 Traffic Analysis

2.2.1 Source Data

The Preliminary Traffic Report presented the results of the traffic data collection effort, analysis of existing traffic conditions, analysis of existing crash data, and analysis of 2040 traffic projections for the No Build Alternative and 2040 Build Alternative.

2.2.2 Traffic Data for Interstate 40 (New Lone Tree TI Study Area)

Design level of service (LOS) and capacity goals for Arizona state roadways are described in the *Roadway Design Guidelines* (RDG) from the ADOT Roadway Engineering Group. The design LOS for various highway types as published in Table 103.2A of the RDG as shown in Table 5.

Table 5 – ADOT RDG LOS Criteria

Controlled Access Highway Type	Design LOS
Level Terrain	B
Rural / Rolling Terrain	B
Mountainous Terrain	B-C
Urban / Fringe Urban Areas	C-D

The Flagstaff Urban Area Functionally Classified Road (2005) map was used to classify mainline segments according to highway type and design LOS. The segment of I-40 within the TI study area is classified as Urban / Fringe Urban with a design goal of LOS C.

Existing (2008) Conditions

Seasonal adjustment factors are used to adjust short-duration vehicle counts to annual average daily traffic volumes. ADOT MPD staff provided daily and seasonal adjustment factors based on 2008 traffic data obtained from Automatic Traffic Recorder data from two locations on I-40, one location near Winona and a second location near Seligman. An October seasonal adjustment factor of 1.01 was applied to the October 2008 ADT to estimate the 2008 Annual Average Daily Traffic (AADT). Table 6 shows the AADT volumes for the I-40 mainline after applying the daily and seasonal adjustment factors.

Table 6 – I-40 Mainline AADT

Location	Direction	I-40 Mainline AADT
I-17/I-40 System TI to Butler TI	Eastbound	19,994
I-17/I-40 System TI to Butler TI	Westbound	21,052

K, D, and T factors for the study section of I-40 were obtained from ADOT. K is the percentage of the ADT expected to occur in the design hour. D is the percentage of the design hourly volume (DHV) in the direction of heavier flow. T is the percentage of trucks expected in the design hour. The K, D, and T factors for the study section of I-40 are 9%, 53% and 23%, respectively. The Directional Design Hourly Volume (DDHV) is computed as: DDHV = AADT * K * D * T and is expressed in terms of passenger car equivalent traffic. The existing DDHV for the I-40 mainline is 2,633.

I-40 Mainline Level of Service

Ramp and freeway level of service analyses were completed assuming “rolling terrain”. A freeway mainline segment analysis was performed for the I-40 study corridor. Existing traffic in the segment of I-40 between the I-40 / I-17 system TI and the Butler TI operates at LOS C.

2040 No-Build Alternative Capacity Analysis

The 2030 No Build Alternative and 2050 No Build Alternative traffic models for I-40 were provided by FMPO. The models account for existing roadway network conditions, as well as near-term improvements (i.e., committed projects that will be constructed in the near term) within the I-40 design concept study area; however, they do not include any improvements to ADOT facilities along the design concept study section of I-40. FMPO has termed these models as “existing plus committed,” but for consistency they are referred to as “No Build Alternative” models within this report. The 2040 No Build Alternative traffic volumes were interpolated from the volumes produced in the 2030 No Build Alternative and 2050 No Build Alternative models.

The 2040 No Build Alternative average daily traffic for a typical weekday along the I-40 mainline within the New Lone Tree TI study area is 85,085 vehicles.

The 2040 No Build Alternative DDHV for I-40 mainline within the TI study area is 5,459 and results in LOS F. Construction of a third lane in each direction on mainline I-40 will result in LOS D, which meets the design LOS C/D goal for this segment of I-40.

2040 Build Alternative Capacity Analysis

The 2030 Build Alternative and 2050 Build Alternative models include improvements to ADOT facilities through the I-40 design concept study area. These improvements included widening I-40 to three lanes in each direction and constructing four new service interchanges. FMPO has termed these models as “full network”, but for consistency they are referred to as “Build Alternative” models within this report. The 2040 Build Alternative traffic volumes were interpolated from the volumes produced in the 2030 Build Alternative and 2050 Build Alternative models.

The 2040 Build Alternative average daily traffic for a typical weekday along the I-40 mainline within the New Lone Tree TI study area is 90,495.

Table 7 summarizes the 2040 Build Alternative traffic volume projections for the New Lone Tree TI.

Table 7 – 2040 Build Alternative Lone Tree TI Traffic Volume Projections

TI	EB		WB		CROSS ROAD
	OFF-RAMP	ON-RAMP	OFF-RAMP	ON-RAMP	
New Lone Tree TI	7,538	4,105	5,876	5,492	13,757

Table 8 shows the 2040 Build Alternative DDHV for the I-40 mainline in the TI study area.

Table 8 – 2040 Build Alternative I-40 Mainline DDHV

FROM	TO	DDHV
I-40 / I-17 System TI	New Lone Tree TI	5,806
New Lone Tree TI between ramps		4,970
New Lone Tree TI	Butler TI	5,610

Table 9 shows the 2040 Build Alternative DDHV for the proposed service interchange at New Lone Tree Road.

Table 9 – 2040 Build Alternative I-40/New Lone Tree Service Interchange DDHV

TI	EB		WB	
	OFF-RAMP	ON-RAMP	OFF-RAMP	ON-RAMP
New Lone Tree TI	920	501	717	670

The 2040 Build Alternative DDHV for I-40 mainline (3-lane) within the TI study area is 5,806 and results in LOS D, which meets the design LOS C/D goal for this segment of I-40.

A ramp merge and diverge analysis was performed for the service interchanges using the 2040 Build Alternative traffic volumes. The target LOS for ramps was assumed to be the same as the corresponding section of I-40. Table 10 summarizes the results of this analysis.

Table 10 – 2040 Build Alternative New Lone Tree TI Ramp Merge / Diverge LOS

TI	DESIGN LOS	EB		WB	
		OFF-RAMP	ON-RAMP	OFF-RAMP	ON-RAMP
New Lone Tree TI	C/D	D – 31.8	C – 23.0	D – 29.9	C – 24.4

Note: Results shown as LOS – Density (pc/mi/ln)

Where mainline segments are projected to reach LOS D before the 2040 design year, auxiliary lanes are recommended between the on- and off-ramps at adjacent traffic interchanges. These segments and the resulting mainline level of service are shown in Table 11.

Table 11 – 2040 Build Alternative I-40 Mainline With Auxiliary Lanes LOS

LOCATION				DESIGN LOS	NO. OF LANES	LOS	Density (pc/mi/ln)
FROM	TO	BEGIN MP	END MP				
I-40 / I-17 System TI	New Lone Tree TI	195.42	196.70	C/D	3+1	C	22.0
New Lone Tree TI	Butler TI	196.70	198.28	C/D	3+1	C	21.1

3.0 Design Concept Alternatives – New Lone Tree TI

3.1 Introduction

In the early 1990s, Lone Tree Road was formally identified as a candidate location for a new interchange along I-40 to serve Flagstaff and Northern Arizona University. The *I-17/I-40 System Interchange Change of Access Report* (ADOT, May 1993) stipulated that the location of the New Lone Tree TI be shifted away from the system interchange for improved mainline traffic operations. A realignment of Lone Tree Road west of the existing grade separation was proposed in the 1993 report and also shown in the *Lone Tree Corridor Study* (City of Flagstaff, 2006).

Coconino Community College and a planned development, Juniper Point, are located south of I-40 in the interchange area. The land in the northwest quadrant of the interchange is owned by the Arizona Board of Regents, with a new apartment complex, The Ridge at Clear Creek, in the northeast quadrant.

The I-40, Bellemont to Winona, Initial DCR documented the development and evaluation of seven preliminary alternatives for the New Lone Tree TI based on the New Lone Tree Road alignment location described in the previous documents.

3.2 No-TI Alternative

In the No-TI alternative, the I-40 corridor would be widened to three lanes in each direction without adding a TI at Lone Tree Road. The existing grade-separated crossing would remain.

The estimated cost for the I-40 mainline improvements without a TI is $43,500,000. This cost includes pavement replacement, replacement of the existing Lone Tree Road overpass bridges, noise walls, and other highway infrastructure between the I-17 overpass bridges and the Rio de Flag bridges.

3.3 Build Alternatives

The build alternatives are grouped and described as follows:

Name	Description
Diamond Configuration	
Diamond Under I-40	Diamond interchange with New Lone Tree Road crossing under I-40. Preferred alternative from the City's 2006 corridor study.
Diamond Over I-40	Diamond interchange with New Lone Tree Road crossing over I-40.
Loop Configuration	
Loop	Interchange with westbound entrance loop and three diamond ramps with New Lone Tree Road crossing under I-40.
Diamond with Loop	Diamond interchange with New Lone Tree Road crossing under I-40 and westbound loop added.
Loop with Collector-Distributor (C-D) Road	Interchange with westbound entrance loop and three diamond ramps with New Lone Tree Road crossing under I-40. I-17 system ramp traffic diverted to C-D road through interchange; westbound entrance loop entrance connects to C-D road.
Braided Configuration	
Braided Ramp Over I-40	Diamond interchange with New Lone Tree Road crossing over I-40. I-17 system ramp traffic diverted to C-D road through interchange; dual westbound entrance ramps required.
Braided Ramp Under I-40	Diamond interchange with New Lone Tree Road crossing under I-40. I-17 system ramp traffic diverted to C-D road through interchange; dual westbound entrance ramps required.
Braided Over I-40, Interim and Ultimate Phases	*Braided Over I-40 alternative constructed in two phases.*
Braided Under I-40, Interim and Ultimate Phases	*Braided Under I-40 alternative constructed in two phases.*

3.3.1 Diamond Under I-40 Alternative

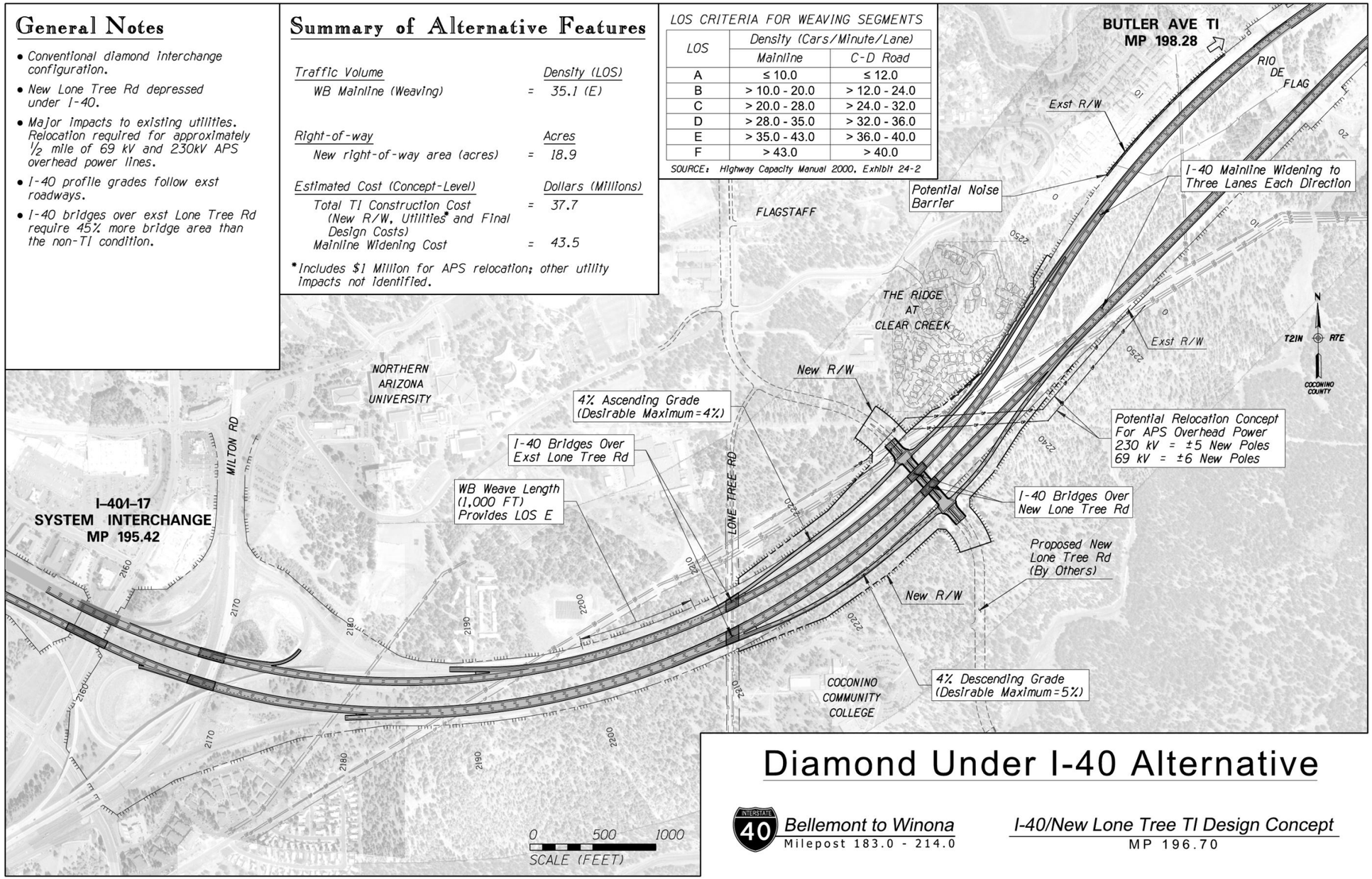
This alternative is a diamond interchange with New Lone Tree Road crossing under I-40 (Figure 4). This concept was shown in the City of Flagstaff's 2006 *Lone Tree Corridor Study* as the preferred configuration by the city.

I-40 has a relatively flat profile grade near the existing Lone Tree Road grade separation, then descends at approximately 3.0% toward the east. The existing elevation of the mainline is approximately 11 feet lower in the westbound direction and 29 feet lower in the eastbound direction at the proposed New Lone Tree Road location than at existing Lone Tree Road. This elevation difference would require steeper grades for the western ramps versus the eastern ramps. The western ramps would be designed to hold maximum grades of 4.0%, which would result in ramps approximately 1800 feet long. The eastern ramps would be approximately 1300 feet long with grades less than 3%. The existing Lone Tree bridges would need to be widened to the inside to accommodate the added I-40 lanes and ramps. However, bridge replacement is recommended because of the age of the bridges (constructed in 1966) and to improve vertical and horizontal clearance and superelevation.

The approximate R/W required for this alternative would be 18.9 acres.

The proximity of the westbound entrance ramp to the I-17 system ramp would provide a weaving length estimated at 1000 feet, which would result in LOS E in the 2040 design year. Since LOS E doesn't meet the minimum design LOS, additional alternatives were developed.

Figure 4 – New Lone Tree TI Diamond Under I-40 Alternative



3.3.2 Diamond Over I-40 Alternative

With this alternative, New Lone Tree Road would cross over I-40 (Figure 5). Reversing the stacking order of the interchange would help the ramp grades of the western ramps. The western ramps could be shortened as much as 700 feet, although the eastern ramps would need to be lengthened. In addition, this configuration with the crossroad over the mainline would assist vehicles on the exit ramps decelerate (upgrade) and vehicles on the entrance ramps accelerate (downgrade). The shortened western ramps would increase the weaving length, thereby improving traffic operations of the nearby system interchange. The weave LOS would be D for this alternative. The grades of the ramps would be a maximum of 5%.

The total new R/W required for this alternative would be approximately 14.6 acres.

3.3.3 Loop Alternative

The Loop Alternative would replace the diamond ramp with a loop ramp for the westbound entrance movement (Figure 6). The westbound exit would shift outward, around the loop ramp, and would intersect New Lone Tree Road approximately 400 feet farther north than either diamond TI configuration. No changes to the eastbound mainline roadway would be required with this alternative. The loop geometrics would result in an increase in the weaving distance at the expense of a lower design speed for entering traffic. Approximately 2900 feet would be provided for weaving, which would result in LOS D. The loop design speed would be 30 mph; traffic would use a portion of the weaving area to accelerate to mainline speed.

Along New Lone Tree Road, the loop would intersect the crossroad on the opposite side of the roadway compared to a typical diamond ramp. This would require carefully-designed signing and marking to instruct drivers how to negotiate the interchange. Additionally, traffic signal phasing would be more complicated and signal progression along Lone Tree Road could be degraded.

When compared to a standard diamond interchange, all of the loop configurations would require an increase in new right-of-way in the northeast quadrant but a decrease in R/W in the northwest quadrant. The increase in R/W needs in the northeast quadrant is undesirable since the new apartments in this quadrant were constructed as low-income housing. Environmental justice issues will be evaluated in the NEPA document associated with the I-40 design concept study. For this alternative, approximately 25.4 acres of new R/W would be required.

3.3.4 Diamond with Loop Alternative

This alternative would be a hybrid between the Diamond Under I-40 Alternative and the Loop Alternative. The interchange would have four diagonal ramps, similar to the Diamond Under I-40 Alternative (Figure 7). Additionally, a westbound entrance loop ramp would be provided. The loop ramp would be signed for traffic destined for I-40 westbound, and the diamond ramp would be used for traffic destined for the I-17 system ramp. Traffic analyses assumed drivers would follow the signage, which resulted in LOS D for the weave. However, once drivers become familiar with the interchange, they could opt to disregard signage and use the diagonal entrance ramp for all movements, regardless of the shorter weave length. This would result in a condition similar to the Diamond Under I-40 Alternative weave, which would operate at LOS E.

The new apartments in the northeast quadrant of the interchange would be affected by this alternative. The total new R/W required for this alternative is approximately 33.7 acres.

3.3.5 Loop with C-D Road Alternative

This alternative would use a loop ramp for the westbound entrance movement (Figure 8). However, instead of connecting the loop directly into the westbound mainline, a collector-distributor (C-D) road would be added and the loop connected to the C-D road. The C-D road would remove westbound system ramp traffic destined for I-17 and Milton Road from the mainline in advance of the New Lone Tree TI.

Traffic destined for I-17 (southbound) or Milton Road (northbound) would exit westbound I-40 approximately 4500 feet in advance of the existing departure point. The C-D road would occupy the same position as the existing westbound mainline roadway, requiring realignment of the westbound I-40 roadway toward the median. Entering traffic from Lone Tree Road would connect to the C-D road. Vehicles not destined for the system interchange would weave to a slip ramp to connect to the mainline. In this configuration, the weaving operation would take place on the C-D road only and not the mainline. The weave LOS on the C-D road would be D+, and the mainline would be LOS B.

Similar to the loop alternative, the loop design speed would be 30 mph and traffic would use a portion of the C-D road to accelerate to ramp speed. This alternative would share other features with the loop alternative along the crossroad and east of New Lone Tree Road.

The new apartments in the northeast quadrant of the interchange also would be affected by this alternative. The Loop with C-D Road Alternative would require approximately 25.4 acres of new R/W.

Figure 5 – New Lone Tree TI Diamond Over I-40 Alternative

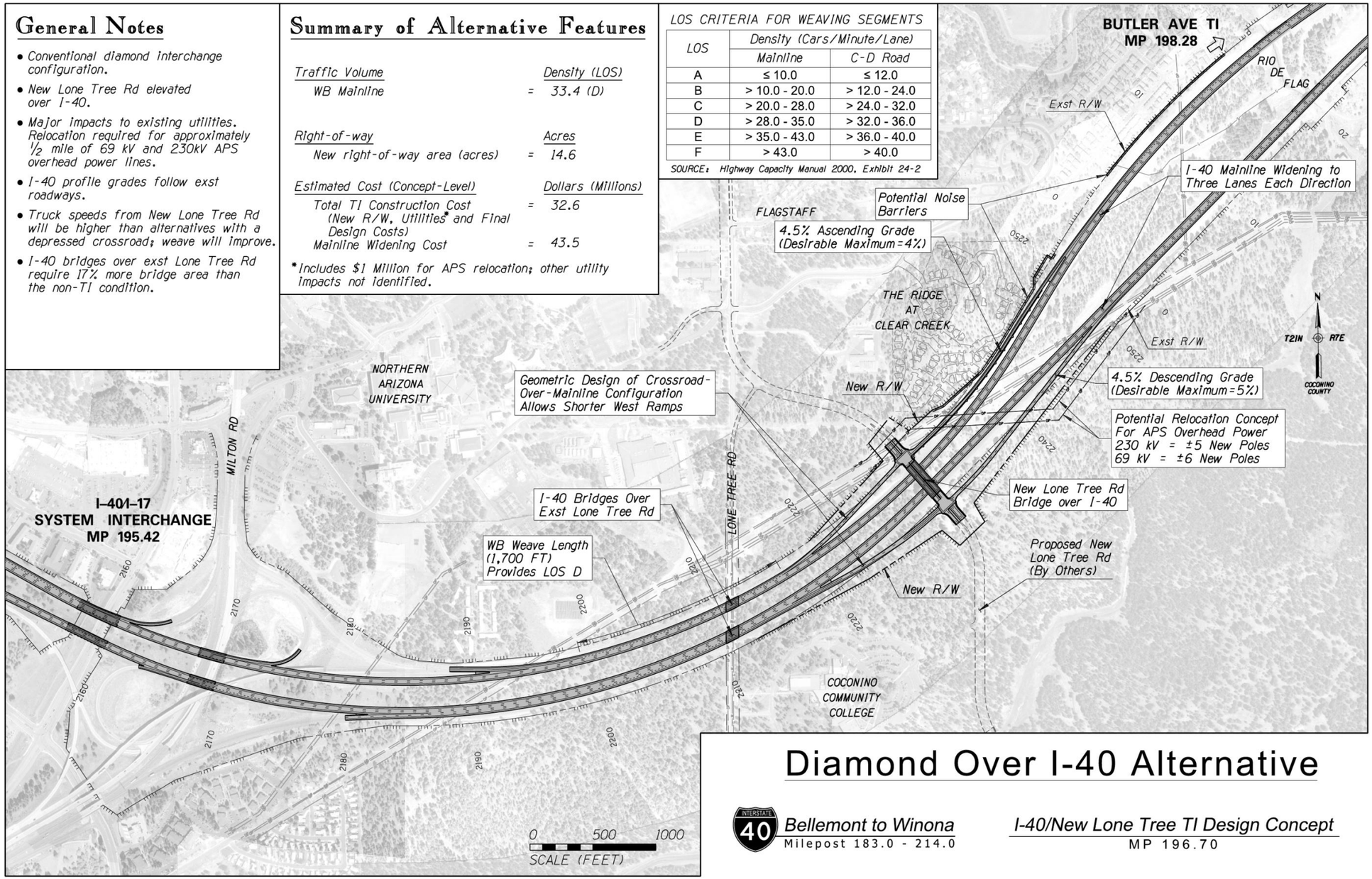


Figure 6 – New Lone Tree TI Loop Alternative

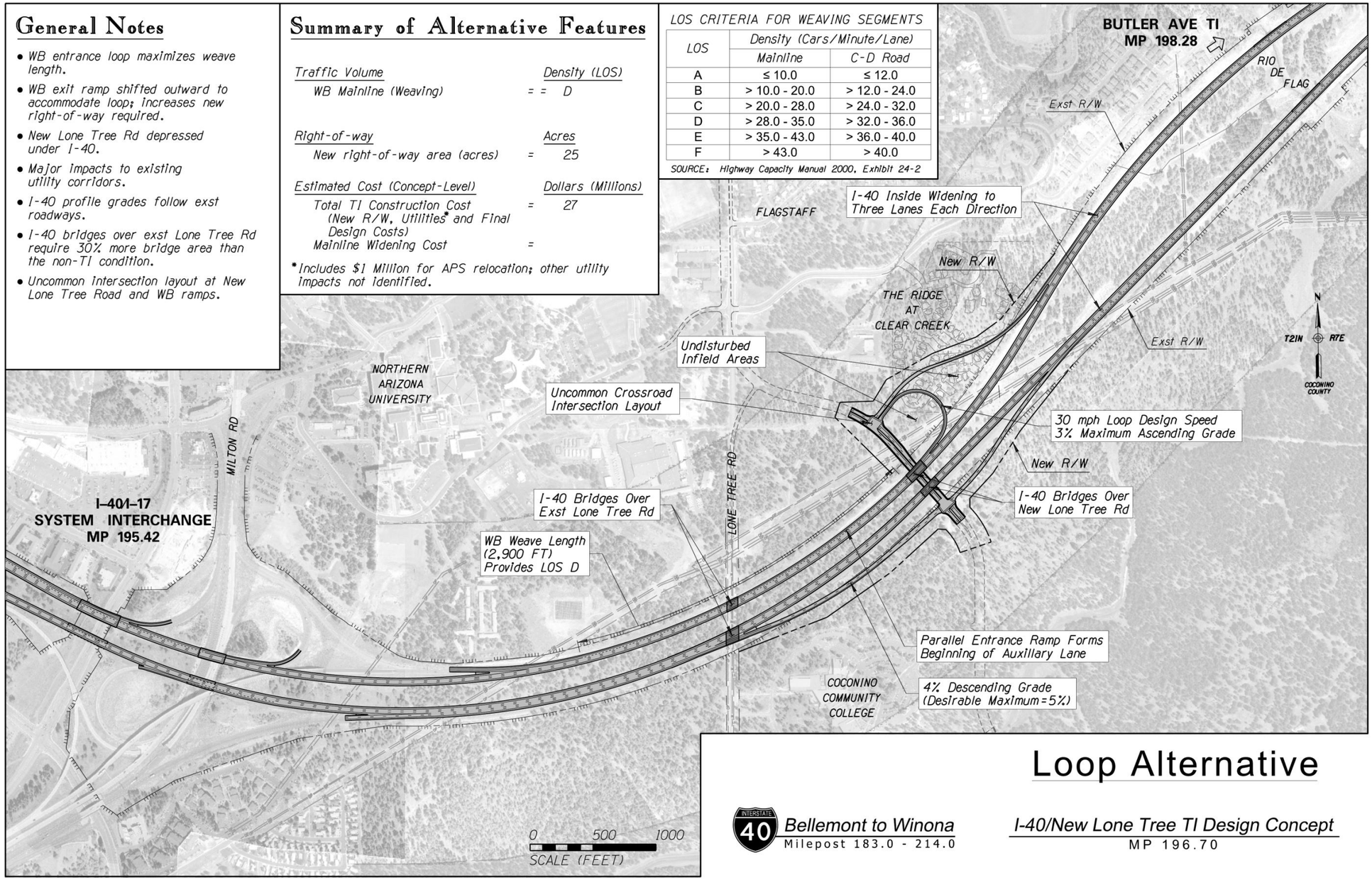


Figure 7 – New Lone Tree TI Diamond with Loop Alternative

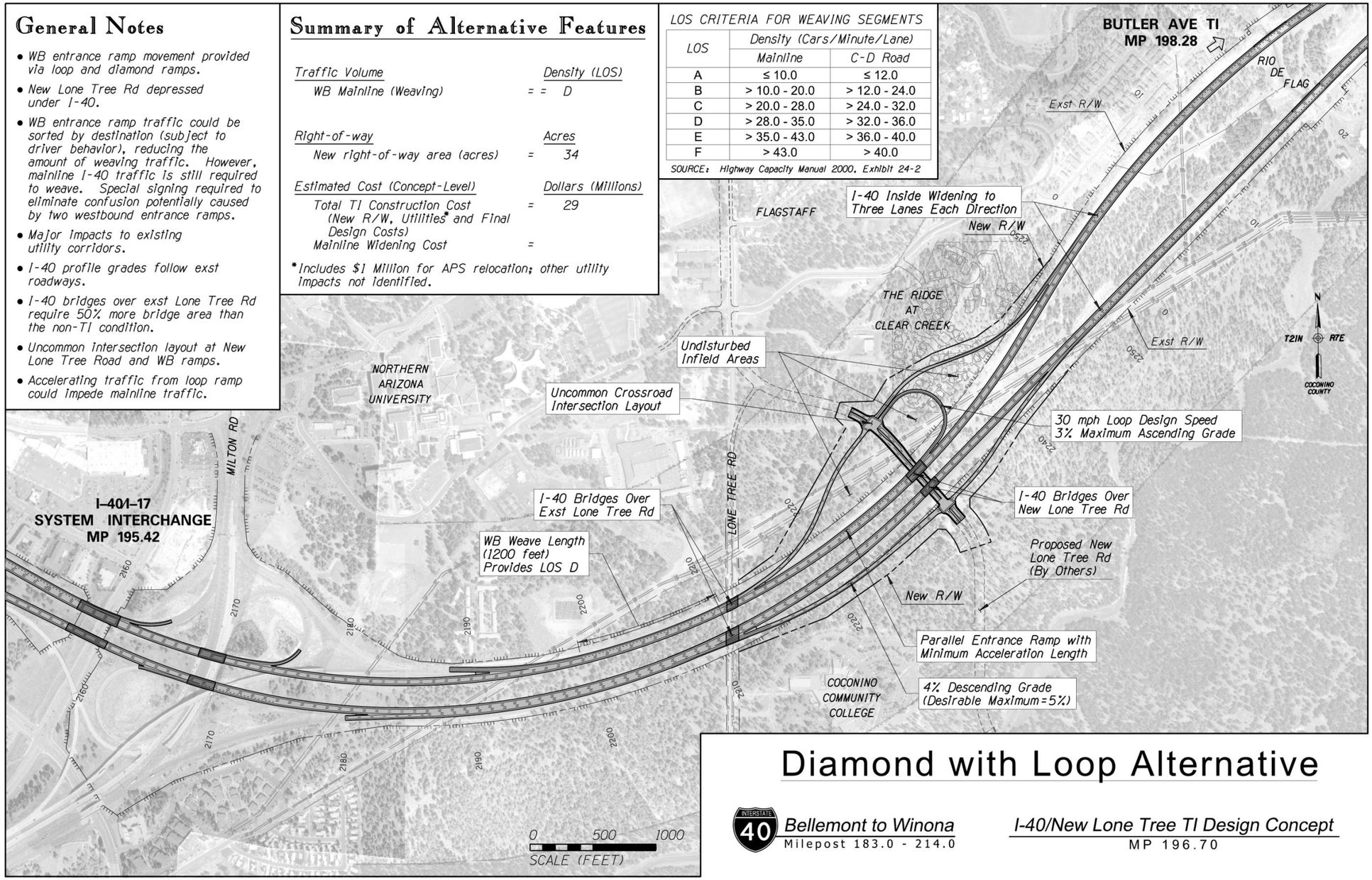
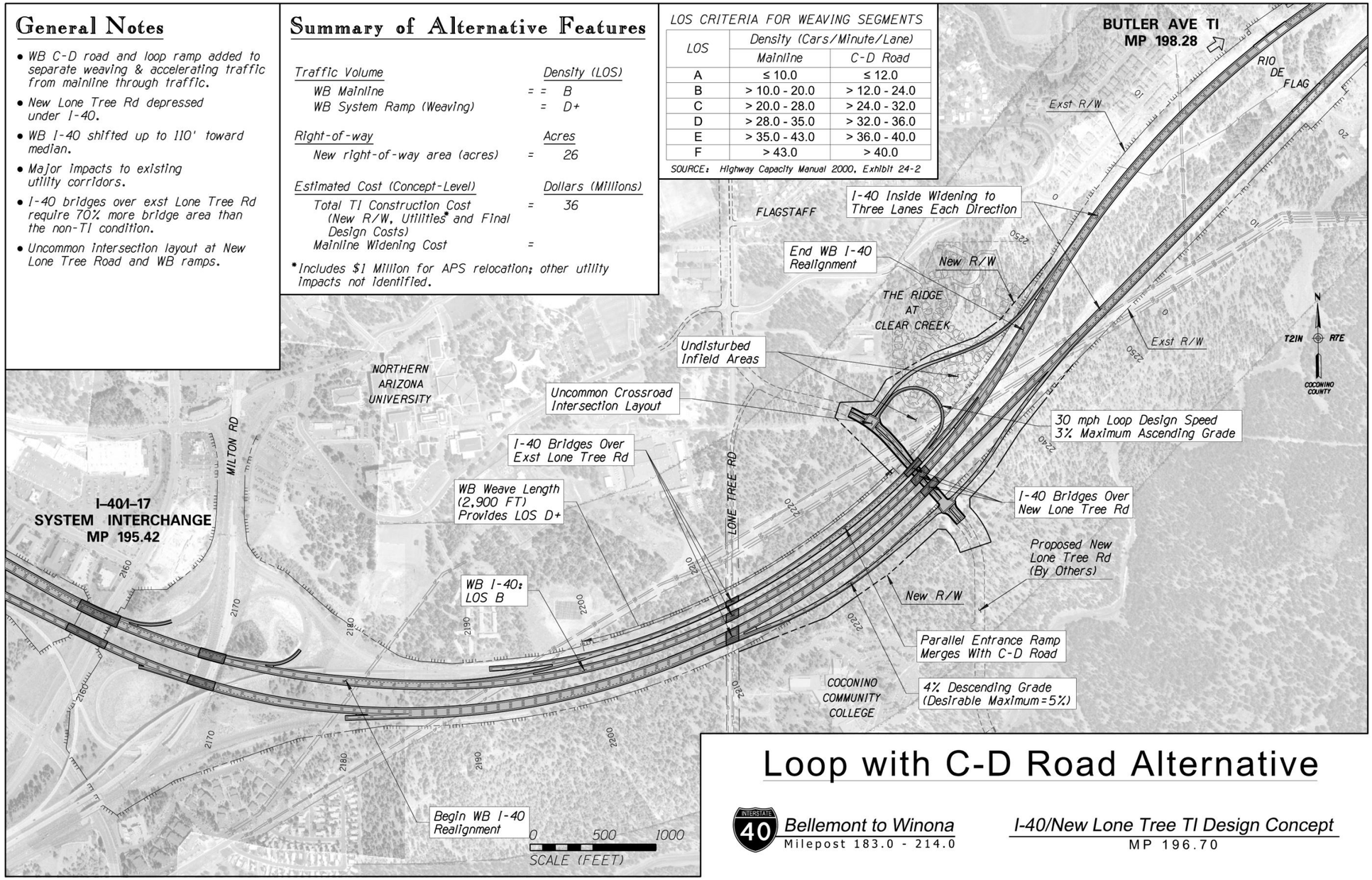


Figure 8 – New Lone Tree TI Loop with C-D Road Alternative



3.3.6 Braided Over I-40

The Braided Over I-40 alternative (Figure 9) would provide a braided ramp configuration for the westbound I-40 to southbound I-17/Milton Road system interchange. The braided concept would reduce mainline widening by shifting all entering and exiting traffic to a parallel C-D road. The C-D road would be a separate, long exit ramp for traffic destined for southbound I-17 or Milton Road. It also would accommodate entering westbound New Lone Tree TI traffic destined for either the I-17/Milton ramp or to westbound I-40. For the Braided Over alternative, the LOS for the westbound system ramp weave would be C and the westbound I-40 mainline would be LOS B.

Approximately 1.3 miles of westbound I-40 would need to be realigned in the median area. This shift reduces the need for new R/W on the north side of I-40 and minimizes R/W impacts to the new low-income housing in the northeast quadrant. The existing westbound I-40 bridge over Lone Tree Road would need to be replaced to accommodate the shifted horizontal alignment and raised mainline profile. Also a new bridge for the C-D road and New Lone Tree ramp merge would be constructed in the same general location as the existing westbound bridge over existing Lone Tree Road. The existing eastbound bridge over Lone Tree Road would need to be widened to the inside; however, replacement of this bridge would also be recommended. An additional bridge for the westbound braided ramp over the C-D ramp road and retaining walls would be required.

Features of the non-braided diamond alternatives would also be part of this alternative with regard to the diamond interchange ramp lengths and grades. The approximate R/W requirements would be 18.9 acres for the Braided Over Alternative.

3.3.7 Braided Under I-40

The Braided Under I-40 alternative (Figure 10) would provide a braided ramp configuration for the westbound I-40 turning movements. This braided concept is similar to the Braided Over I-40 concept except that the crossroad would travel under I-40. Similar to the Braided Over I-40 alternative, the level of service for the westbound system ramp weave would be LOS C and the westbound I-40 mainline would be LOS B.

Identical to the Braided Over I-40 Alternative, approximately 1.3 miles of westbound I-40 would need to be realigned in the median area. The existing westbound I-40 bridge over Lone Tree Road would need to be replaced to accommodate the shifted horizontal alignment and raised mainline profile. Also a new bridge for the C-D road and New Lone Tree ramp merge would be constructed in the same general location as the existing westbound bridge over existing Lone Tree Road. The existing eastbound bridge over Lone Tree Road would need to be widened to the inside; however, replacement of this bridge would also be recommended. An additional bridge for the C-D ramp road over the New Lone Tree westbound entrance ramp and retaining walls would be required.

Features of the non-braided diamond alternatives would also be part of this alternative with regard to the diamond interchange ramp lengths and grades. The approximate R/W requirements would be 19.9 acres for the Braided Under Alternative.

3.3.8 Braided Over I-40 (Phased Construction)

The braided concepts create more complicated design and construction than a traditional diamond interchange, resulting in higher costs; however, these concepts would result in more efficient and safer operations. If required for funding or other reasons, the braided concepts could be constructed in interim and ultimate phases.

The Braided Over I-40 alternative could be constructed into two phases. The “interim” phase (Figure 11) would resemble the Diamond Over I-40 concept. The ultimate westbound C-D road would be used for the interim I-40 westbound roadway. An additional 16 feet of pavement would be required along the C-D road alignment to accommodate the third additional through lane and 10-foot shoulders on both sides. The existing westbound bridge would be replaced to accommodate the wider interim width of the C-D road and the New Lone Tree westbound entrance ramp (in the ultimate condition, this ramp will provide access only to southbound I-17 and Milton Road). The crossroad bridge would be constructed in the interim phase to provide access to I-40. The crossroad traffic will not be impacted during the ultimate construction which includes the realignment of the westbound roadway. The interim westbound entrance ramp and the I-40/I-17 system TI exit ramp to southbound I-17 and northbound Milton Road traffic would provide a weave length which operates at a LOS E.

The interim westbound entrance ramp will become the portion of the slip ramp that provides access from the New Lone Tree TI to the I-40/I-17 system TI and Milton Road. This ramp can be constructed in its ultimate location. In the ultimate concept the westbound entrance ramp to I-40 would cross over the C-D road. This ultimate westbound entrance ramp portion of the ramp split configuration could be constructed to the back of the gore at the split location or the eastern bridge abutment. This will reduce the impacts to the I-40 mainline traffic during the ultimate construction phase.

The realigned westbound roadway would be constructed in the second phase, as well as the remaining half of the westbound entrance ramp over the C-D ramp roadway. Due to the phasing of the construction, the structure over the C-D road will be longer to allow for the increased width of the interim C-D road. The eastbound structure over existing Lone Tree Road would be constructed to its ultimate width.

The right-of-way for the ultimate concept (18.9 acres) should be obtained during the interim phase.

3.3.9 Braided Under I-40 (Phased Construction)

The Braided Under I-40 Ultimate phase can similarly be constructed into two phases. The interim phase (Figure 12) would resemble the Diamond Under I-40 concept. The ultimate westbound C-D road would be used for the interim I-40 westbound roadway. An additional 16 feet of pavement would be required along the C-D road alignment to accommodate the third additional through lane and 10-foot shoulders on both sides. The existing westbound bridge would be replaced to accommodate the wider interim width of the C-D road and the New Lone Tree westbound entrance ramp (in the ultimate condition, this ramp will only provide access to southbound I-17 and Milton Road and not I-40 westbound). The interim westbound entrance ramp and the I-17/I-40 system TI exit ramp to southbound I-17 and northbound Milton Road traffic would provide a weave length which operates at a LOS E.

In order to construct the ultimate C-D road on its ultimate horizontal and vertical alignments between existing Lone Tree Road and the realigned New Lone Tree Road, a temporary detour would be required. This detour of I-40 westbound traffic would provide the opportunity to construct the C-D ramp structure over the ultimate westbound entrance ramp. The interim version of this structure requires the structure to be wider than needed for the ultimate configuration. It is possible to build this structure during the final phase, when the interim C-D road is constructed closer to existing grade. However, during that final phase, I-40 westbound and I-17 southbound access would be limited from the New Lone Tree TI until completion.

The C-D road/I-40 mainline bridge over the New Lone Tree crossroad could be constructed in phases as well. The structure could be constructed to provide the required width for just the interim condition or to its ultimate width to limit the future impacts to the crossroad during the westbound realignment construction.

The two structures in the eastbound direction would be constructed to their ultimate widths. One structure would replace the existing Lone Tree overpass structure and the other would be a new structure over the New Lone Tree TI crossroad.

The right-of-way for the ultimate concept (19.9 acres) should be obtained during the interim phase.

Figure 9 – New Lone Tree TI Braided Over I-40 Alternative

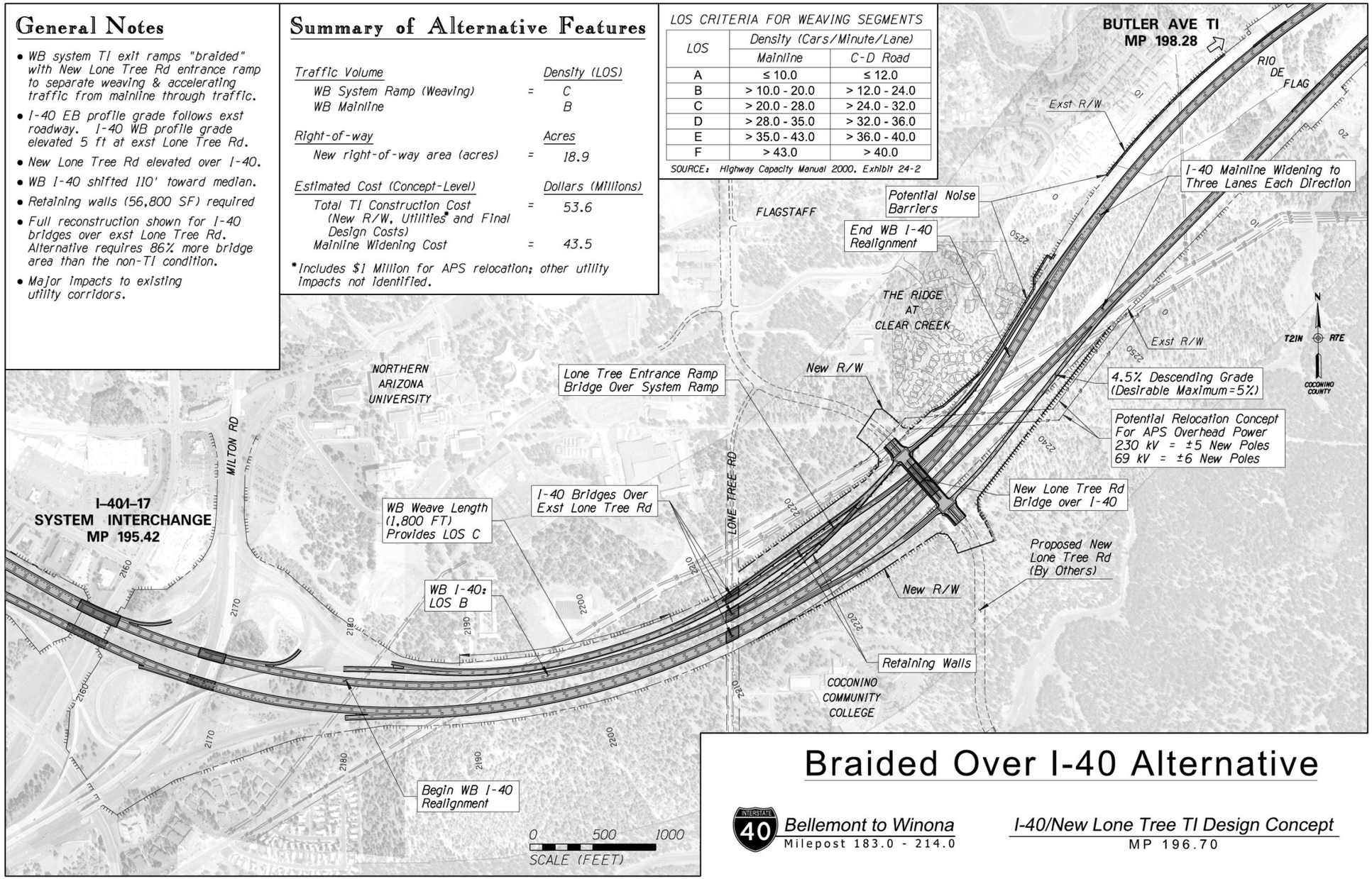


Figure 10 – New Lone Tree TI Braided Under I-40 Alternative

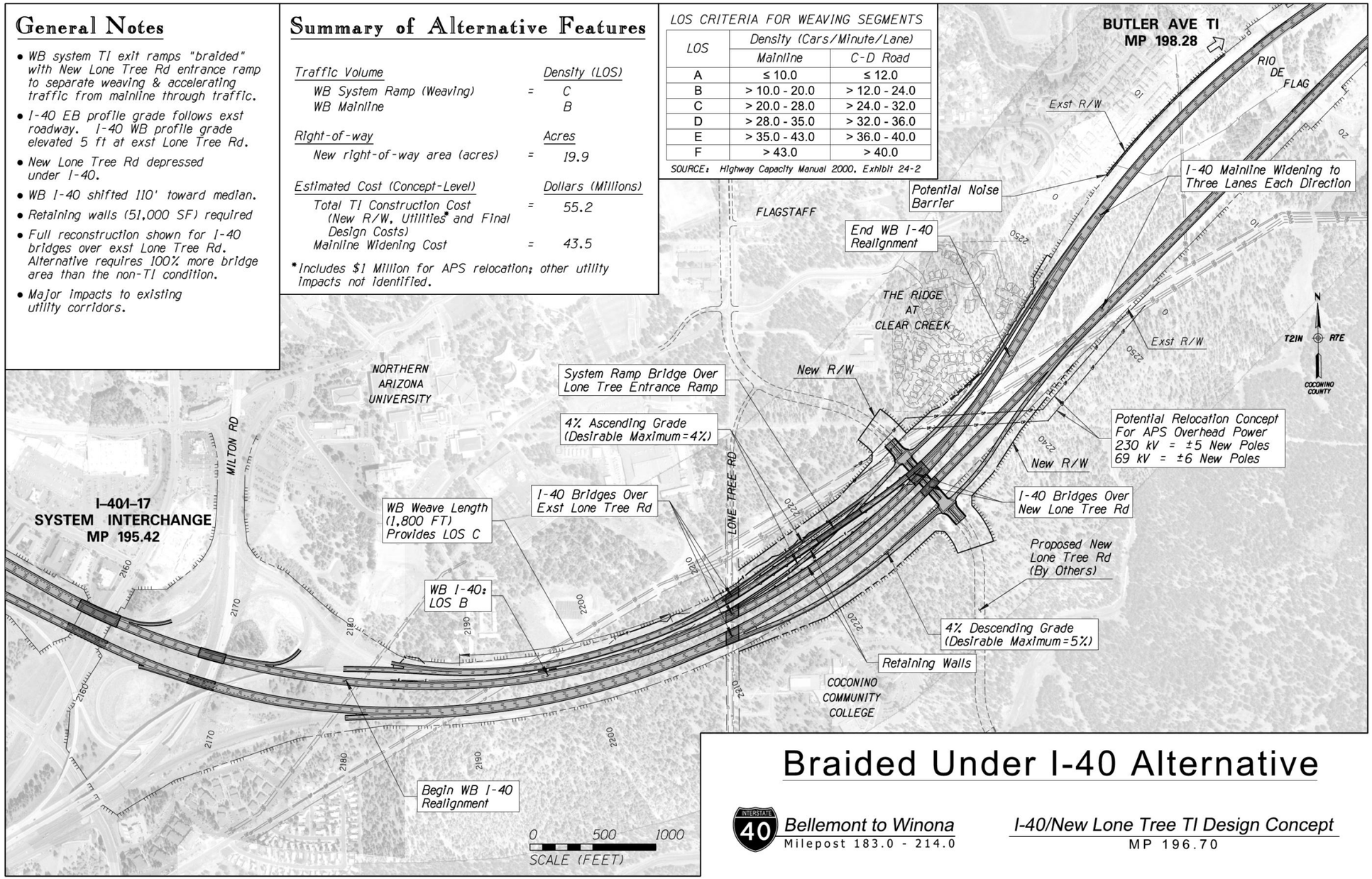


Figure 11 – New Lone Tree TI Braided Over I-40 Alternative (Interim Construction Phase)

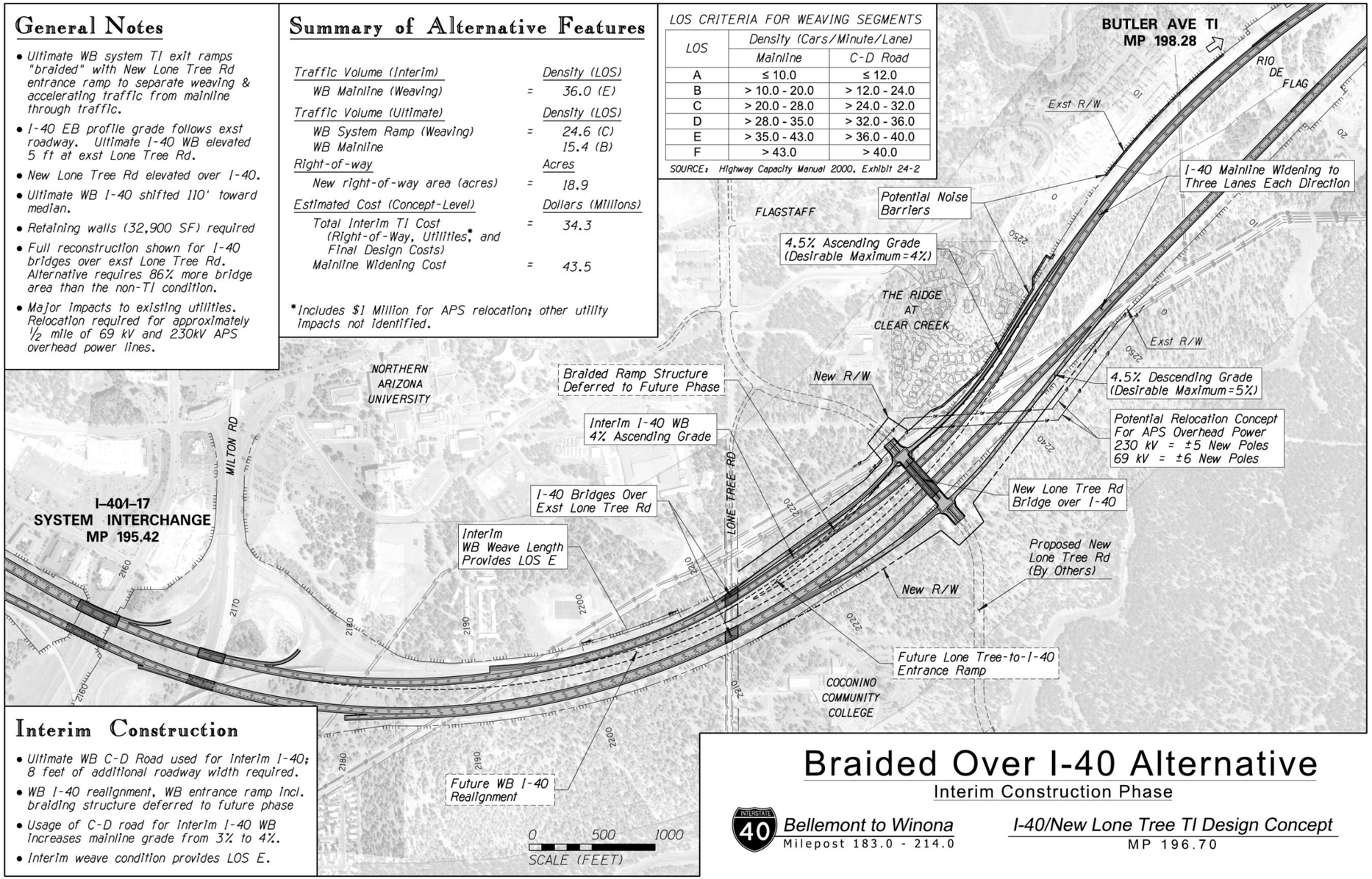
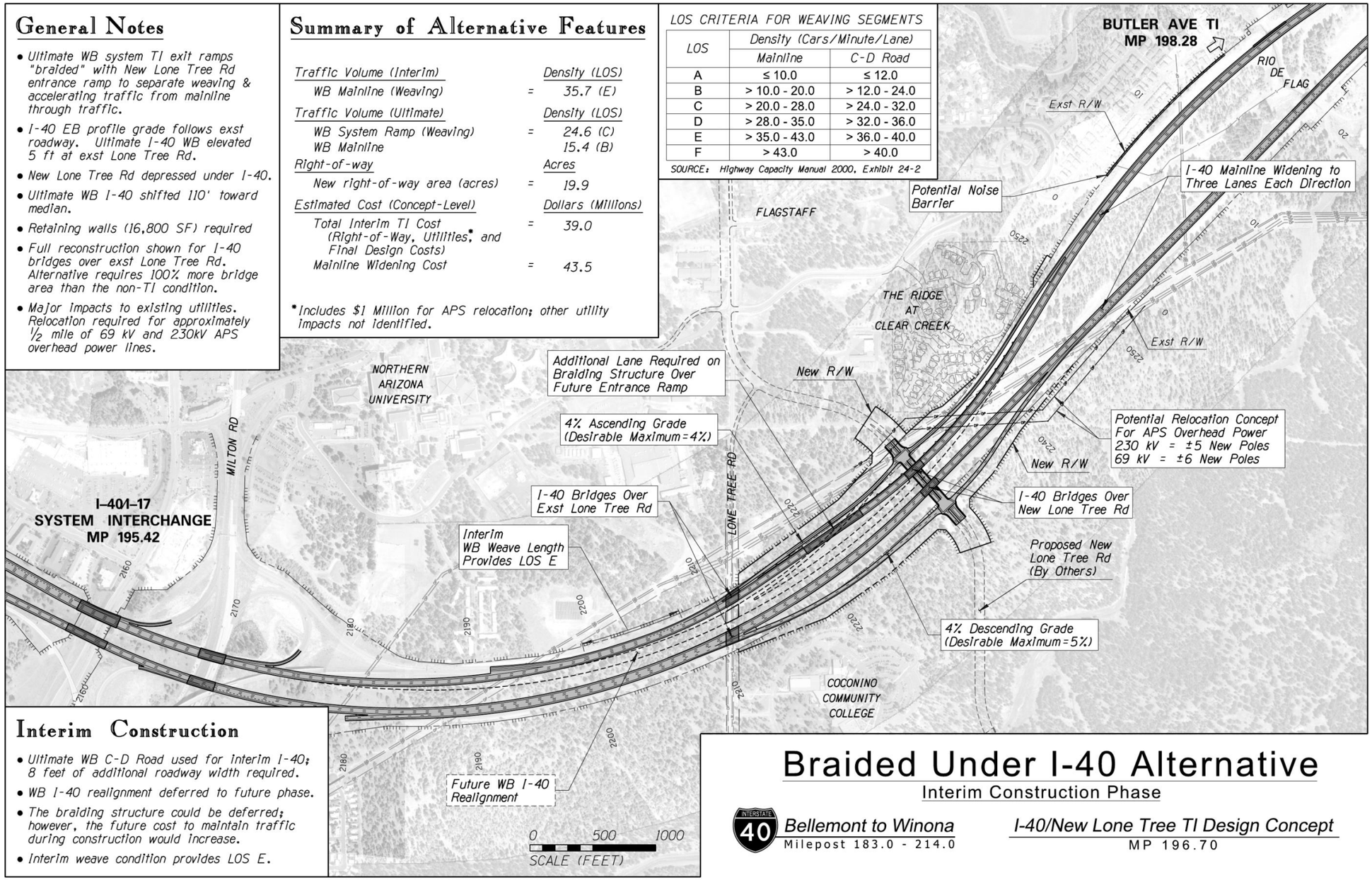


Figure 12 – New Lone Tree TI Braided Under I-40 Alternative (Interim Construction Phase)



3.4 Alternatives Evaluation

The alternatives with loop ramps in the northeast quadrant (Loop Alternative, Loop with Diamond Alternative, Loop with C-D Road Alternative) were eliminated early in the alternatives development phase because of poor operational performance (LOS D), R/W needs, impacts to development in the northeast quadrant of the interchange, and irregular intersection configurations.

The Diamond and Braided alternatives were developed further, discussed with the agency stakeholders, and evaluated. The evaluation matrixes on the following pages explore several cases:

Case 1: Build interchange without widening mainline

Case 1A: Sensitivity analysis to test Case 1 with traffic volumes increased 20%

Case 2: Build interchange and reconstruct/widen mainline

Case 2A: Sensitivity analysis to test Case 2 with traffic volumes increased 20%

The evaluation of the Diamond and Braided alternatives included the following evaluation criteria:

- LOS/sensitivity to changes in traffic volumes
- Estimated construction cost
- R/W needs
- Implementation opportunities
- Vehicle weave conflicts

Recommendations

The Loop alternatives (Loop, Loop with Diamond, and Loop with C-D Road) are not recommended for the following reasons:

- Similar/low LOS compared to other conventional alternatives.
- Impacts to apartments to the north.
- Uncommon crossroad intersection layout
- 30 mph maximum design speed for loop ramp. Traffic must accelerate and merge onto the mainline in a short distance.
- Large amount of new R/W required.

The Diamond Over I-40 Alternative is not recommended for the following reasons:

- LOS D weave in the design year.
- Braided alternatives provide better LOS and higher capacity well into future years.
- Requires ramp grades of 5% maximum.

The Diamond Under I-40 Alternative is not recommended for the following reasons:

- LOS requirement not met in design year.
- Perched water table issues could increase construction and maintenance costs.
- Longer western ramps result in shorter weave lengths adjacent to system interchange.
- Roadside snow storage areas restricted by retaining walls and concrete barrier.

The Braided Alternatives (Over and Under) are recommended for further study for the following reasons:

- LOS requirements are exceeded in the design year, even without westbound mainline widening.
- Braided alternatives provide high LOS beyond design year.
- Could be constructed in phases.

TABLE 12 – NEW LONE TREE TI ALTERNATIVES EVALUATION MATRIXES – CASE 1 AND CASE 1A

CASE 1 – BUILD INTERCHANGE WITHOUT WIDENING MAINLINE

The following evaluation matrix is based on New Lone Tree TI construction occurring without I-40 mainline widening and reconstruction. The diamond alternatives would connect to the existing I-40 roadways; however, the braided alternatives would require realigning approximately 1.3 miles of westbound I-40.

Criterion	No-TI Alternative	Diamond Over I-40	Diamond Under I-40	Diamond with Braided Ramps Over I-40	Diamond with Braided Ramps Under I-40	COMMENT/ CONCLUSION
Description	Maintains existing grade separation for Lone Tree Road. No improvements to existing infrastructure.	New compact diamond TI. Mainline not widened.	New compact diamond TI. Mainline not widened.	New diamond TI with system ramp braided across diamond entrance ramp. I-17 system ramp traffic diverted to C-D road through TI. Reconstruct approx. 1.3 miles of WB I-40.	New diamond TI with system ramp braided across diamond entrance ramp. I-17 system ramp traffic diverted to C-D road through TI. Reconstruct approx. 1.3 miles of WB I-40.	--
New Lone Tree Road Over/Under I-40	N/A	Over	Under	Over	Under	2006 Lone Tree Road corridor study recommended "Under."
Level of Service / Sensitivity (Density) Note that the LOS are subject to change by varying input parameters. Assumed opening in 2015.	N/A	I-40 Weave LOS 2015: E (35.3) 2030: Transition to F 2040: F (47.9)	I-40 Weave LOS 2015: E (37.2) 2026: Transition to F 2040: F (50.5)	I-40 Mainline LOS 2015: B (13.6) 2040: C (24.1) C-D Road Weave LOS 2015: B (23.9) 2040: C (24.6)	I-40 Mainline LOS 2015: B (13.6) 2040: C (24.1) C-D Road Weave LOS 2015: B (23.9) 2040: C (24.6)	The **BRAIDED** alternatives are the only alternatives that offer an acceptable LOS. The Diamond alternatives have an unacceptable LOS in the opening year (2015 assumed).
Safety / Conflict Evaluation Estimate of the number of vehicles required to weave and the number of vehicles impacted by an uphill truck merging over a 30-second timeframe. A lower number is better. *Total is multiplied by 3 when LOS = F	No change	Number of weaving veh: 2686 Impact of uphill trucks: 0 Total: 8058 *	Number of weaving veh: 2686 Impact of uphill trucks: 2094 Total: 14,339 *	Number of weaving veh: 1305 Impact of uphill trucks: I-40 mainline: 0 C-D Road: 0 Total: 1305	Number of weaving veh: 1305 Impact of uphill trucks: I-40 mainline: 568 C-D Road: 479 Total: 2352	The **BRAIDED** alternatives require fewer vehicles to weave. The alternatives with New Lone Tree Road **OVER** I-40 eliminate conflict with uphill/slow trucks merging with high speed traffic.
Estimated R/W (Preliminary)	0 acres	14.6 acres	18.9 acres	18.9 acres	19.9 acres	**DIAMOND OVER** requires the least amount of new R/W.
Estimated Construction Cost (Preliminary, rounded. Includes R/W, final design. Does not include remaining utility relocation or environmental mitigation costs except for noise barriers.)	$0	$32,600,000 (TI) +$2,800,000 (I-40*) $35,400,000 (Total) *Cost for interim tie-in to existing I-40.	$37,700,000 (TI) +$2,900,000 (I-40*) $40,600,000 (Total) *Cost for interim tie-in to existing I-40.	$53,600,000 (TI) +$11,600,000 (I-40*) $65,200,000 (Total) *Cost for interim tie-in to existing EB I-40 and reconstruction of one mile of WB I-40.	$55,200,000 (TI) +$18,300,000 (I-40*) $73,500,000 (Total) *Cost for interim tie-in to existing EB I-40 and reconstruction of one mile of WB I-40.	**DIAMOND OVER** and **BRAIDED OVER** have the lowest costs associated with their alternative configuration.

Criterion	No-TI Alternative	Diamond Over I-40	Diamond Under I-40	Diamond with Braided Ramps Over I-40	Diamond with Braided Ramps Under I-40	COMMENT/ CONCLUSION
Visual Impacts	Not measured.	Elevated interchange has higher visual impact.	Depressed interchange offers lower visual impact.	Elevated interchange has higher visual impact.	Depressed interchange offers lower visual impact.	**UNDER** alternatives recommended.
Noise Impacts	Not measured.	Elevated interchange has lower noise impact.	Depressed interchange results in higher noise impact.	Elevated interchange has lower noise impact.	Depressed interchange results in higher noise impact.	**OVER** alternatives recommended.

CASE 1A – BUILD INTERCHANGE WITHOUT WIDENING MAINLINE – INCREASE TRAFFIC VOLUMES 20%

The following evaluation is based on a scenario where projected traffic volumes are increased 20% evenly throughout the Case 1 network to test the sensitivity of the projections.

Criterion	No-TI Alternative	Diamond Over I-40	Diamond Under I-40	Diamond with Braided Ramps Over I-40	Diamond with Braided Ramps Under I-40	COMMENT/ CONCLUSION
Level of Service Traffic volumes increased 20% from Case 1 base model.	N/A	Not computed; LOS is E without increased volumes.	Not computed; LOS is E without increased volumes.	<u>I-40 Mainline LOS</u> 2015: B (16.3) 2018: Transition to C 2030: Transition to D 2040: D (32.0) <u>C-D Road Weave LOS</u> 2015: C (30.3) 2040: C (31.0)	<u>I-40 Mainline LOS</u> 2015: B (16.3) 2018: Transition to C 2030: Transition to D 2040: D (32.0) <u>C-D Road Weave LOS</u> 2015: C (30.3) 2040: C (31.0)	Only the **BRAIDED** alternatives offer an acceptable LOS in the design year.

TABLE 13 – NEW LONE TREE TI ALTERNATIVES EVALUATION MATRIXES – CASE 2 AND CASE 2A

CASE 2 – BUILD LONE TREE TI AND RECONSTRUCT/WIDEN MAINLINE

The following evaluation matrix is based on New Lone Tree TI construction occurring simultaneously with I-40 mainline widening and reconstruction. Alternatives with a loop ramp in northeast quadrant were eliminated because of impacts to apartments and uncommon ramp/crossroad intersection configurations.

Criterion	No-TI Alternative	Diamond Over I-40	Diamond Under I-40	Diamond with Braided Ramps Over I-40	Diamond with Braided Ramps Under I-40	COMMENT/ CONCLUSION
Description	Maintains existing grade separation for Lone Tree Road. Reconstruct/widen I-40 to improve mainline capacity.	New compact diamond TI. Reconstruct/widen I-40 to improve mainline capacity.	New compact diamond TI. Reconstruct/widen I-40 to improve mainline capacity.	New diamond TI with system ramp braided across diamond entrance ramp. I-17 system ramp traffic diverted to C-D road through TI. Reconstruct/widen I-40 to improve mainline capacity.	New diamond TI with system ramp braided across diamond entrance ramp. I-17 system ramp traffic diverted to C-D road through TI. Reconstruct/widen I-40 to improve mainline capacity.	--
New Lone Tree Road Over/Under I-40	N/A	Over	Under	Over	Under	2006 Lone Tree Road corridor study recommended "Under."
Implementation	N/A	Construct improvements with one project.	Construct improvements with one project.	Improvements can be constructed as one project or in two phases.	Improvements can be constructed as one project or in two phases.	Project is less complicated to construct and less expensive if only one phase is involved.
Level of Service / Sensitivity Assumed opening in 2015. Note that LOS are subject to change by varying input parameters.	N/A	<u>I-40 Weave LOS</u> 2015: C (24.7) 2025: Transition to D 2040: D (33.4)	<u>I-40 Weave LOS</u> 2015: C (25.9) 2021: Transition to D 2040: Transition to E 2040: E (35.1)	<u>I-40 Mainline LOS</u> 2015: A (9.1) 2040: B (15.4) <u>C-D Road Weave LOS</u> 2015: C (24.3) 2040: C (24.6) **Interim Phase Only** <u>I-40 Weave LOS</u> 2015: C (26.6) 2019: Transition to D 2037: Transition to E 2040: E (36.0)	<u>I-40 Mainline LOS</u> 2015: A (9.1) 2040: B (15.4) <u>C-D Road Weave LOS</u> 2015: C (24.3) 2040: C (24.6) **Interim Phase Only** <u>I-40 Weave LOS</u> 2015: C (26.3) 2020: Transition to D 2038: Transition to E 2040: E (35.7)	The **BRAIDED** alternatives offer the best level of service; however, the **DIAMOND OVER** meets ADOT criteria.
Safety / Conflict Evaluation Estimate of the number of vehicles required to weave and the number of vehicles impacted by an uphill truck merging over a 30-second timeframe. A lower number is better.	No change	Number of weaving veh: 2686 Impact of uphill trucks: 0 Total: 2686	Number of weaving veh: 2686 Impact of uphill trucks: 1396 Total: 4082	Number of weaving veh: 1305 Impact of uphill trucks: I-40 mainline: 0 C-D Road: 0 Total: 1305	Number of weaving veh: 1305 Impact of uphill trucks: I-40 mainline: 378 C-D Road: 479 Total: 1683	The **BRAIDED** alternatives require fewer vehicles to weave. The alternatives with New Lone Tree Road **OVER** I-40 eliminate conflict with uphill/slow trucks merging with high speed traffic.
Traffic Operations (Weaving Length)	None	Weaving length = 1,700 ft	Weaving length = 1,200 ft	Weaving length (Interim Phase) = 1,000 ft	Weaving length (Interim Phase) = 1,000 ft	**DIAMOND OVER** and **BRAIDED** (ultimate phase) alternatives provide longest weave lengths.

Criterion	No-TI Alternative	Diamond Over I-40	Diamond Under I-40	Diamond with Braided Ramps Over I-40	Diamond with Braided Ramps Under I-40	COMMENT/ CONCLUSION
Driver Expectancy	No change	Good driver expectancy.	Good driver expectancy.	Moderate driver expectancy with potential for some confusion due to presence of two westbound entrance ramps.	Moderate driver expectancy with potential for some confusion due to presence of two westbound entrance ramps.	Conventional **DIAMOND** interchanges are more common. Braided alternatives acceptable.
Utility Impacts (Estimated impacts to APS OH transmission and distribution lines)	None	Major impacts to APS overhead power. $1,000,000 included in the TI cost estimate for overhead power line relocation. Other utility impacts not quantified.	Major impacts to APS overhead power. $1,000,000 included in the TI cost estimate for overhead power line relocation. Other utility impacts not quantified.	Major impacts to APS overhead power. $1,000,000 included in the TI cost estimate for overhead power line relocation. Other utility impacts not quantified.	Major impacts to APS overhead power. $1,000,000 included in the TI cost estimate for overhead power line relocation. Other utility impacts not quantified.	All alternatives require similar relocations of APS overhead 69kV and 230kV power lines. Other utility impacts not quantified.
Drainage / Snow Removal Issues	No change	Interchange drains to Rio de Flag via roadside earthen ditches.	Low point on crossroad drains to Rio de Flag via storm drain system in I-40 median.	Interchange drains to Rio de Flag via roadside earthen ditches. Areas next to retaining walls have limited snow storage capacity.	Low point on crossroad drains to Rio de Flag via storm drain system in I-40 median. Areas next to retaining walls have limited snow storage capacity.	The Under alternatives create a sump that requires storm drain system; **OVER** alternatives do not and therefore are preferred. The braided alternatives have a constrained cross section that inhibits snow storage.
Estimated R/W (Preliminary)	0 acres	14.6 acres	18.9 acres	18.9 acres	19.9 acres	**DIAMOND OVER** requires the least amount of new R/W; however, all alternatives are similar.
Right-of-Way Impact to Apartments (The Ridge at Clear Creek)	None	New R/W required; limited to area previously dedicated for interchange improvements.	New R/W required; limited to area previously dedicated for interchange improvements.	New R/W required; limited to area previously dedicated for interchange improvements.	New R/W required; limited to area previously dedicated for interchange improvements.	All alternatives limit the new R/W area to the area previously dedicated for interchange improvements.
Estimated Construction Cost (Preliminary, rounded. Includes R/W, final design. Does not include remaining utility relocation or environmental mitigation costs except for noise barriers.) Note: I-40 costs include reconstruction/widening of mainline from east of I-17 OP structure to west of Rio de Flag bridges, including replacement of bridges over "old" Lone Tree Rd.	$0	$32,600,000 (TI) + $43,500,000 (I-40) $76,100,000 (Total)	$37,700,000 (TI) + $43,500,000 (I-40) $81,200,000 (Total)	$53,600,000 (TI) + $43,500,000 (I-40) $97,100,000 (Total) Or, if built in phases: *Interim:* $34,300,000 (Interim TI) + $43,500,000 (I-40) $77,800,000 (Subtotal Phase 1) *Ultimate:* $19,300,000 (remaining TI elements) + $6,100,000 (re-work) $25,400,000 (Subtotal Phase 2) $103,200,000 (Total)	$55,200,000 (TI) + $43,500,000 (I-40) $98,700,000 (Total) Or, if built in phases: *Interim:* $39,000,000 (Interim TI) + $43,500,000 (I-40) $82,500,000 (Subtotal Phase 1) *Ultimate:* $16,200,000 (remaining TI elements) + $6,600,000 (re-work) $22,800,000 (Subtotal Phase 2) $105,300,000 (Total)	**DIAMOND OVER** has the least costs. Braided alternatives have nearly identical total costs; however, the **BRAIDED OVER** has a lower interim phase cost.

Criterion	No-TI Alternative	Diamond Over I-40	Diamond Under I-40	Diamond with Braided Ramps Over I-40	Diamond with Braided Ramps Under I-40	COMMENT/ CONCLUSION
Retaining Walls (Preliminary)	N/A	1 wall 26,950 SF	2 walls 37,500 SF	4 walls 56,800 SF	5 walls 51,000 SF	All alternatives require retaining wall in the northeast quadrant near the apartments. The braided alternatives require additional wall near the braiding structure.
Visual Impacts	Not measured.	Elevated interchange has higher visual impact.	Depressed interchange offers lower visual impact.	Elevated interchange has higher visual impact.	Depressed interchange offers lower visual impact.	**UNDER** alternatives recommended.
Noise Impacts	Not measured.	Elevated interchange has lower noise impact.	Depressed interchange results in higher noise impact.	Elevated interchange has lower noise impact.	Depressed interchange results in higher noise impact.	**OVER** alternatives recommended.

CASE 2A – BUILD INTERCHANGE AND WIDEN MAINLINE – INCREASE TRAFFIC VOLUMES 20%

The following evaluation is based on a scenario where projected traffic volumes are increased 20% evenly throughout the Case 2 network to test the sensitivity of the projections.

Criterion	No-TI Alternative	Diamond Over I-40	Diamond Under I-40	Diamond with Braided Ramps Over I-40	Diamond with Braided Ramps Under I-40	COMMENT/ CONCLUSION
Level of Service Traffic volumes increased 20% from Case 2 base model.	N/A	I-40 Weave LOS 2015: D (30.9) 2024: Transition to E 2040: E (41.9)	I-40 Weave LOS 2015: D (32.6) 2020: Transition to E 2038: Transition to F 2040: F (44.1)	I-40 Mainline LOS 2015: B (11.0) 2038: Transition to C 2040: C (18.6) C-D Road Weave LOS 2015: C (30.3) 2040: C (31.0)	I-40 Mainline LOS 2015: B (11.0) 2038: Transition to C 2040: C (18.6) C-D Road Weave LOS 2015: C (30.3) 2040: C (31.0)	Only the **BRAIDED** alternatives offer an acceptable LOS in the design year. The Diamond alternatives fall below LOS D in 2020 and 2024.

4.0 Major Design Features of the New Lone Tree TI

4.1 Introduction

The I-40 Initial DCR recommended widening the mainline and constructing a new interchange at New Lone Tree Road. This chapter will explore the major design features associated with the recommended I-40 widening and new traffic interchange at the proposed New Lone Tree Road.

4.2 Design Controls

The mainline reconstruction and new traffic interchange will be designed to meet current ADOT RDG and AASHTO design guidelines. City of Flagstaff Engineering Standards will be used for the design of New Lone Tree Road. Table 14 presents the preliminary mainline and ramp design criteria used to develop the recommended alternative.

Table 14 – Preliminary Design Criteria

DESCRIPTION OF CRITERION	VALUE FOR DESIGN
Design Year:	2040
Elevation Range:	6840 feet to 6980 feet
Level of Service: Urban / Fringe-Urban Area:	 C - D (RDG, Table 103.2A)
Design Speed: Mainline: Ramp Exit at Mainline Gore: Ramp Entrance at Mainline Gore: Ramp Body: Ramp Terminus: New Lone Tree Road:	 65 mph Mainline design speed minus 5 mph (RDG, Section 503.3) Mainline design speed minus 10 mph (RDG, Section 503.3) 50 mph (RDG, Section 503.3) 35 mph (RDG, Section 503.3) 40 mph
Lane Width: I-40 New Lone Tree Road	 12 feet (RDG, Section 301.3) 12' through lane, 11' aux lane (COF Engrg Stds)
Shoulder Width: Outside Shoulder Inside Shoulder	(RDG, Table 302.4) (Truck DDHV > 250) 12 ft. (incl. 2' offset to barrier) (3 or more lane section) 10 ft. + 2' offset to barrier (adjacent to auxiliary lane and/or 2-lane section) 12 ft. (incl. 2' offset to barrier) (3 or more lane section) 4 ft. + 2' offset to barrier (2-lane section)
Superelevation: I-40 (Elevation > 6000'): New Lone Tree Road:	 e_{max}=0.060 '/ft. (RDG, Table 202.1B) e_{max}=0.040 '/ft
Median Width: I-40: New Lone Tree Road:	 84 feet desirable (50 feet minimum) (RDG, Sec. 304.1, Figure 304.3B) 15 feet (min.)
Median Barrier:	Required if median width ≤ 75 feet and natural barriers are not present with 3 or more lanes in each direction (RDG, Section 304.4)
Minimum Horizontal Curve Length: I-40: New Lone Tree Road:	 15 x design speed (mph): (RDG, Section 203.5) 975 feet 600 feet
Maximum Degree of Curve:	3°27' (RDG, Table 202.3B)
Maximum Gradient: Mainline: Ramps: Upgrade Downgrade New Lone Tree Road:	 3% (RDG, Table 204.3) 4% desirable, 6% maximum (RDG, Section 504.1) 5% desirable, 6% maximum (RDG, Section 504.1) 6% maximum
Normal Cross Slope:	2.0% (RDG, Section 301.2, Figure 306.2)
Side Slope:	Std C-02.10(RDG, Figure 306.2) plus, when applicable, cut slope modifications for rockfall containment and fill slope flattening to eliminate need for guardrail
Minimum Vertical Curve Length I-40: New Lone Tree Road:	 1000 feet (RDG, Table 204.4) 120 feet
Taper Rate (Lane Drop): Taper Rate (Lane Addition):	Design speed (mph) to one: (RDG, Section 207) 65:1 25:1 (RDG, Section 207)
Horizontal/Lateral Clearances: Clear Zone / Recovery Area Width:	(RDG, Section 308, Section 303.2, Table 303.2) 30 feet
Minimum Vertical Clearance (I-40): Overpass Underpass Sign Structure	(RDG, Section 206.4) 16.5 feet 16.5 feet 18.0 feet
Type of Access Control I-40: New Lone Tree Road:	 Full Access Control Full Access Control min. 300' from ramp PCR's

4.3 Horizontal and Vertical Alignments

4.3.1 Typical Section

The proposed typical section for the widened I-40 roadways consists of three 12-foot travel lanes and 12-foot inside and outside shoulders, for a total width of 60 feet. The eastbound lanes in this segment of I-40 will be widened by adding pavement to the inside of the existing section.

New Lone Tree Road's proposed typical section is two 12-foot travel lanes in each direction, a 12-foot two-way left turn lane, bike lanes, and sidewalks. The typical section will also provide a 10-foot FUTS trail on one side.

The standard cross slope will be 0.020'/ft in tangent sections. Superelevation rates for horizontal curves on mainline I-40 are based on ADOT RDG Table 202.3.

4.3.2 Horizontal Alignment

It is recommended that westbound I-40 be realigned toward the median to provide space for the C-D road and minimize the need for new R/W.

The westbound alignment will be realigned up to 110 feet toward the median from the existing alignment beginning east of the I-17/I-40 system TI at Station 2175+00. The alignment will be located within the existing median for approximately 1.3 miles, then tie back into the existing alignment at Station 2250+00.

4.3.3 Vertical Alignment

The vertical alignment follows the existing terrain within the median. The maximum grade of the realigned westbound alignment is +3.0%. The proposed vertical curve lengths will be a minimum of 1000 feet. The roadway profile outside of the realigned area will follow the westbound profile as reflected in the I-40 Initial DCR.

4.4 Access

I-40 is an controlled-access facility. A Change of Access Report was approved for the proposed New Lone Tree Road connection to I-40 in 1993; however, a new/updated Change of Access Report will be prepared in conjunction with the I-40 design concept study and submitted to FHWA for approval.

4.5 Right-of-Way

New right-of-way is necessary for the New Lone Tree TI. The approximate R/W requirements would be 19.9 acres for the Braided Under Alternative and 18.9 acres for the Braided Over Alternative.

Right-of-way lines shown on the drawings in this technical memorandum are based on limits of disturbance identified by the conceptual design layout and may not indicate the final right-of-way requirements or easements necessary for construction. Actual limits will be established during the final design process.

There are a number of section corners in the project area which are in or near the roadway. The monuments shall be preserved or replaced if disturbed by construction.

4.6 Drainage Considerations

A preliminary drainage report was prepared for the I-40 design concept study in May 2010.

Proposed improvements for drainage elements along I-40 in the New Lone Tree TI study area involve the extension of reinforced concrete box culverts or pipe culverts. These extensions were recommended with consideration of the clear zone requirements. A storm drain system will be required to drain the “Lone Tree Under” alternatives.

4.7 Section 404 of the Clean Water Act

Coordination with the US Army Corps of Engineers (COE) will be necessary during project design to ascertain the need for any nationwide or individual permits required under Section 404 of the Clean Water Act. Any deposition of fill material or excavation below the ordinary high water mark will require a permit. Construction activities that would require permits include, but are not limited to, bridge pier construction, culvert installations, replacements and/or extensions requiring excavation and placement of fill material, and roadway embankment widening.

4.8 Earthwork

Discussions of earthwork factors, cut and fill slope recommendations, material sources, debris flows and rock falls, collapsible soils and expandable soils were included in the I-40 Initial DCR. The shrink potential for the native soils throughout this segment of I-40 was estimated at 5%.

All disturbed areas will be seeded.

4.9 Constructability and Traffic Control

Existing highway movements and access must be maintained during construction. Since the westbound lanes will be on a new alignment for the ultimate configuration of the braided alternatives, construction activities can be undertaken with relatively little disruption to existing I-40 traffic other than the portions which tie into the existing freeway. Temporary concrete barrier is recommended where necessary to protect the work area from freeway traffic.

Final construction sequencing/phasing will be determined during final design. Traffic will be managed using detailed traffic control plans and by procedures and guidelines specified in the Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition, the Arizona Supplement to the 2009 MUTCD, and the ADOT Traffic Control Design Guidelines.

Construction activities that disrupt traffic are to be performed during off-peak hours.

4.10 Utilities

During final design, each utility company will receive and review the preliminary design for this project and develop plans for any relocations and/or adjustments. Existing utility information indicates that there are major power lines crossing within the New Lone Tree TI study area that will require relocation.

4.11 Structures

The existing Lone Tree Road grade separation structures will be removed and replaced. The proposed bridges for the new braided alternatives are included as part of the cost estimate of each alternative.

4.12 Preliminary Pavement Design

ADOT Materials provided recommendations for preliminary pavement designs for the I-40 study. The three pavement sections for the TI study area used for the cost estimate are listed below.

LOCATION	RECONSTRUCTION
I-40, MP 195.0 to MP 202.3 Eastbound and westbound (Travel Lanes)	1” AR-ACFC 14” Dowelled PCCP 4” PBTB 4” AB
I-40, MP 195.0 to MP 202.3 Eastbound and westbound (Auxiliary Lanes and Shoulders)	1” AR-ACFC 14” PCCP 4” PBTB 4” AB
Ramps and cross roads Urban	1" AR-ACFC 10” PCCP 4” AB

4.13 Flagstaff Urban Trail System (FUTS)

The FUTS is a citywide interconnecting network of non-motorized transportation corridors and linear recreation areas. The trail system crosses I-40 in numerous locations. Where possible, the trail crossings use bridges to cross over I-40. At other locations, the trail system utilizes equipment passes and box culverts to cross beneath the freeway.

Table 15 lists the existing and proposed trail crossings in the area of the New Lone Tree TI, with locations, sizes, and a "comments" column to describe actions by ADOT or by others to accommodate the trails.

Table 15 – Recommendations for FUTS Crossings

I-40 TRAIL CROSSINGS						RECOMMENDED DESIGN CONCEPT				
Trail Name	**Milepost**	**Existing**	**Planned**	**Over/Under I-40**	**Crossing Structure**	**Remain in place**	**Not recommended**	**Design now**	**Design future**	**Comments**
Lone Tree Trail	196.2	X		Under	Lone Tree OP	X				I-40 bridge replacements will be designed to maintain similar trail characteristics.
New Lone Tree Trail	196.5		X	Over*	New Lone Tree TI UP*			X		New Lone Tree TI will include trail crossing on cross road.

Notes:
Remain in-place = I-40 improvements will not affect existing or planned trail.
Not recommended = I-40 improvements will not affect trail; however, trail crossing is not recommended.
Design now = I-40 improvements will affect trail crossing; modifications can be accommodated with I-40 project(s).
Design future = I-40 improvements will affect trail crossings; address with future project(s).
*Assumes Lone Tree Over I-40 alternative

4.14 Social, Economic, and Environmental Considerations

The environmental elements of the proposed Lone Tree TI as discussed in this technical memorandum will be addressed in the environmental assessment for the I-40 design concept study.

5.0 Itemized Estimate of Probable Costs

The estimate of probable construction cost (2012 dollars) for the braided alternatives are shown below. A detailed estimate of probable cost for each alternative is shown on the following page. The estimated costs are based upon unit prices from ADOT's Construction Cost Data Base and recent bid data in current 2012 dollars. The pavement structural sections used for the cost estimate were a combination of flexible and rigid pavement sections as detailed in the Initial DCR.

Lone Tree TI Alternative	Interchange Costs	Total Combined Costs
Braided Over	$53,600,000	$97,100,000
Braided Under	$55,200,000	$98,700,000

The pavement sections for the New Lone Tree TI study area used for the cost estimate are listed in Section 4.13.

The estimated cost for construction of the widening of I-40 within the New Lone Tree TI study limits is $43,500,000.

The following assumptions were also used for the cost estimate:

- Estimated costs for the new R/W acquisition for the project are included ($200,000/acre).
- Utility relocations are required.
- Clearing and grubbing includes removal of trees.
- The roadway excavation item does not differentiate rock excavation from soil excavation. The unit price for excavation was developed with respect to potential added costs associated with rock excavation.
- All culverts are extended to the appropriate clear zone requirements or width of roadway widening, whichever distance is greater.
- The total cost for each size of box culvert extension and new headwall(s) was computed. Unit prices reflect the cost per linear foot including the headwalls.
- Existing end sections for pipe culverts are unsalvageable.
- Structural backfill costs were included in the cost of the drainage elements and other structure related items.
- Overhead power utility relocations were assumed to be $1,000,000.
- The noise mitigation recommendations shown on the plan sheets are preliminary. A unit cost of $33 per square foot is included for noise barrier wall.
- Hybrid interchange lighting is assumed at the New Lone Tree TI.
- Ground-in rumble strip was included for both sides of the mainline roadways.
- One inch of AR-ACFC was included for bridge deck areas and anchor slabs.
- The estimated costs do not include additional costs that may be incurred by implementing the project in phases.
- For structure cost estimating, the following unit prices were assumed:
  - Concrete ……..…. $300/CY to $450/CY
  - Reinforcing ……..…….…. $1.00/lb
  - Reinforcing (Epoxy Coated) ……. $1.50/lb
  - Structural Steel ……...……... $2.00/lb to $2.50/lb
  - AASHTO PC/PS Girders …….. $195/ft to $230/ft
  - Drilled Shaft Foundations …… $250/ft to $600/ft
  - CIP Retaining Walls ……... $45/SF to $75/SF
- Cost items associated with earthwork, such as roadway excavation, may vary substantially from those to be calculated in final design, when detailed geotechnical mapping will be available.
- Although it is likely the initial construction phase may include a smaller typical section, the cost estimate includes the ultimate roadway section of three lanes and auxiliary lanes on I-40.
- All disturbed areas will be seeded.
- No improvements to washes upstream and downstream of culverts, such as energy dissipators or bank protection, are required.
- Existing PCCP from Rio de Flag bridge replacement project is to remain.
- Mill 1" of AR-ACFC at PCCP limits west of Rio de Flag Bridges
- PCCP smoothness incentive ($3,500/lane mile) was used.
- PCCP material quality incentive ($1.50/sq. yd.) was used.
- AR-ACFC pavement smoothness incentive ($11,000/lane mile) was used.

TABLE 16 – ESTIMATE OF PRELIMINARY CONSTRUCTION COST – BRAIDED OVER ALTERNATIVE

Arizona Department of Transportation
Estimated Engineering Construction Cost
Itemized Estimate

Project Number: 040 CN 183 H758601C
Location: BELLEMONT TO WINONA
Version: Lone Tree TI
Alternative: Braided Over I-40

Braided Over I-40 Interchange Items

Item Description	Unit	Quantity	Unit Price	Amount
REMOVE FENCE	L.FT.	6,716	$ 2.00	$ 13,440.00
ROADWAY EXCAVATION	CU.YD.	89,471	$ 10.00	$ 894,710.00
BORROW	CU.YD.	441,114	$ 10.00	$ 4,411,140.00
AGGREGATE BASE, CLASS 2	CU.YD.	9,204	$ 30.00	$ 276,120.00
AGGREGATE SUBBASE (CLASS 6)	CY	960	$ 35.00	$ 33,600.00
BITUMINOUS TREATED BASE (6" PERMEABLE)	SQ.YD.	17,114	$ 12.00	$ 205,370.00
PORTLAND CEMENT CONCRETE PAVEMENT (10")	SY	55,298	$ 50.00	$ 2,764,900.00
PORTLAND CEMENT CONCRETE PAVEMENT (14" DOWELED)	SQ.YD.	11	$ 60.00	$ 660.00
PORTLAND CEMENT CONCRETE PAVEMENT (14")	SQ.YD.	17,104	$ 58.00	$ 992,040.00
ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT RUBBER) (1")	TON	2,325	$ 45.00	$ 104,630.00
ASPHALT RUBBER MATERIAL (FOR AR-ACFC)	TON	221	$ 700.00	$ 154,700.00
MINERAL ADMIXTURE (FOR AR-ACFC)	TON	22	$ 90.00	$ 1,980.00
BRIDGE (NEW LONE TREE CROSSROAD)	SQ. FT	30,224	$ 120.00	$ 3,626,880.00
BRIDGE (NEW WB ENTRANCE RAMP)	SQ. FT	12,670	$ 120.00	$ 1,520,400.00
BRIDGE (NEW BRAIDED RAMP EXST LONE TREE OP)	SQ. FT	8,641	$ 120.00	$ 1,036,920.00
BRIDGE (NEW I-40 WESTBOUND LONE TREE OP)	SQ. FT	1,790	$ 120.00	$ 214,800.00
BRIDGE (NEW I-40 EASTBOUND EXST LONE TREE OP)	SQ. FT	2,691	$ 120.00	$ 322,920.00
RETAINING WALL	SQ. FT	56,800	$ 45.00	$ 2,556,000.00
DRAINAGE	L. SUM	1	$ 100,000.00	$ 100,000.00
PAVEMENT MARKING - YELLOW	L.FT.	11,250	$ 0.60	$ 6,750.00
PAVEMENT MARKING - WHITE	L.FT.	41,250	$ 0.60	$ 24,750.00
PAVEMENT MARKING - ARROWS & LEGEND	EACH	26	$ 75.00	$ 1,950.00
PAVEMENT MARKING - PAINT BULLNOSE	EACH	5	$ 50.00	$ 250.00
PAVEMENT MARKING - TYPE C RECESSED MARKERS	EACH	600	$ 5.00	$ 3,000.00
SIGNING - MAINLINE CATILEVER	EACH	4	$ 40,000.00	$ 160,000.00
SIGNING - SIGN BRIDGE	EACH	5	$ 80,000.00	$ 400,000.00
SIGNING - CROSSROAD BRIDGE	EACH	5	$ 28,000.00	$ 140,000.00
SIGNING - GUIDE SIGNS	EACH	9	$ 2,000.00	$ 18,000.00
SIGNING - REGULATORY, WARNING, OR MARKER	EACH	11	$ 1,000.00	$ 11,000.00
SIGNING - REGULATORY, WARNING, OR MARKER (DOUBLE)	EACH	11	$ 1,200.00	$ 13,200.00
TRAFFIC SIGNAL	EACH	2	$ 150,000.00	$ 300,000.00
LIGHTING - POLE ASSEMBLY	EACH	90	$ 5,000.00	$ 450,000.00
LIGHTING - ELECTRICAL DISTRIBUTION	L.FT.	22,500	$ 15.00	$ 337,500.00
LIGHTING - LOAD CENTER	EACH	1	$ 10,000.00	$ 10,000.00
LIGHTING - NEW ELECTRIC SERVICE	L.SUM	1	$ 10,000.00	$ 10,000.00
CHAIN LINK FENCE	L.FT.	7,882	$ 8.00	$ 63,060.00
GUARD RAIL, W-BEAM, TYPE 1	L.FT.	7,993	$ 20.00	$ 159,860.00
GUARD RAIL, END TERMINAL ASSEMBLY	EACH	4	$ 3,000.00	$ 12,000.00
CONCRETE CURB AND GUTTER	L.FT.	1,401	$ 20.00	$ 28,020.00
CONCRETE SINGLE CURB	L.FT.	708	$ 20.00	$ 14,160.00
CONCRETE SIDEWALK	SQ. FT.	7,398	$ 5.00	$ 36,990.00
Braided Over I-40 Interchange Items	**DETAILED ESTIMATE SUBTOTAL**			**21,431,700**

I-40 Mainline Widening Items

Item Description	Unit	Quantity	Unit Price	Amount
REMOVE EXISTING CONCRETE MEDIAN BARRIER	L.FT.	1,762	$ 4.50	$ 7,930.00
REMOVAL OF ASPHALTIC CONCRETE PAVEMENT	SQ YD	85,505	$ 2.50	$ 213,770.00
REMOVAL OF STRUCTURES AND OBSTRUCTIONS	L.SUM	1	$ 25,000.00	$ 25,000.00
REMOVE BITUMINOUS PAVEMENT (MILLING) (1")	SQ.YD.	17,078	$ 1.50	$ 25,620.00
CLEARING AND GRUBBING	ACRE	25	$ 2,000.00	$ 50,000.00
ROADWAY EXCAVATION	CU.YD.	261,517	$ 10.00	$ 2,615,170.00
AGGREGATE BASE, CLASS 2	CU.YD.	21,836	$ 30.00	$ 655,080.00
AGGREGATE SUBBASE (CLASS 6)	CY	6,100	$ 35.00	$ 213,500.00
BITUMINOUS TREATED BASE (6" PERMEABLE)	SQ.YD.	128,187	$ 12.00	$ 1,538,250.00
PORTLAND CEMENT CONCRETE PAVEMENT (14" DOWELED)	SQ.YD.	67,413	$ 60.00	$ 4,044,780.00
PORTLAND CEMENT CONCRETE PAVEMENT (14")	SQ.YD.	60,775	$ 58.00	$ 3,524,950.00
LOAD TRANSFER DOWEL ASSEMBLY (12-FT)	EACH	3,478	$ 110.00	$ 382,580.00
ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT RUBBER) (1")	TON	7,716	$ 45.00	$ 347,220.00
ASPHALT RUBBER MATERIAL (FOR AR-ACFC)	TON	733	$ 700.00	$ 513,100.00
MINERAL ADMIXTURE (FOR AR-ACFC)	TON	70	$ 90.00	$ 6,300.00
BRIDGE (NEW I-40 WESTBOUND EXST LONE TREE OP)	SQ. FT	8,168	$ 120.00	$ 980,160.00
BRIDGE (NEW I-40 EASTBOUND EXST LONE TREE OP)	SQ. FT	7,028	$ 120.00	$ 843,360.00
DRAINAGE	L. SUM	1	$ 100,000.00	$ 100,000.00
PAVEMENT MARKING - YELLOW	L.FT.	30,938	$ 0.60	$ 18,570.00
PAVEMENT MARKING - WHITE	L.FT.	46,407	$ 0.60	$ 27,850.00
ITS - LANDLINE SYSTEM	L.FT.	10,350	$ 75.00	$ 776,250.00
ITS - DETECTION STATIONS	EACH	4	$ 20,000.00	$ 80,000.00
SIGNING - MILE POST MARKERS	EACH	4	$ 250.00	$ 1,000.00
SIGNING - GUIDE SIGNS	EACH	1	$ 2,000.00	$ 2,000.00
SIGNING - REGULATORY, WARNING, OR MARKER	EACH	2	$ 1,000.00	$ 2,000.00
SEEDING (CLASS II)	ACRE	15	$ 2,800.00	$ 42,000.00
GUARD RAIL, W-BEAM, TYPE 1	L.FT.	8,202	$ 20.00	$ 164,040.00
GUARD RAIL, END TERMINAL ASSEMBLY	EACH	12	$ 3,000.00	$ 36,000.00
CONCRETE BARRIER (C10.99)	L.FT.	1,762	$ 80.00	$ 140,960.00
NOISE BARRIER WALL	SQ.FT.	45,453	$ 33.00	$ 1,499,950.00
I-40 Mainline Widening Items	**DETAILED ESTIMATE SUBTOTAL**			**18,877,390**

Arizona Department of Transportation
Estimated Engineering Construction Cost
Itemized Estimate

Project Number: 040 CN 183 H758601C
Location: BELLEMONT TO WINONA
Version: Lone Tree TI
Alternative: Braided Over I-40

COMBINED DETAILED ESTIMATE SUBTOTAL				**40,309,090**
MISCELLANEOUS WORK (15%)	COST	15.0%		6,046,400
Subtotal 1				**46,355,490**
DUST PALLIATIVE (1%)	COST	1.0%		463,600
FURNISH WATER (1%)	COST	1.0%		463,600
MAINTENANCE AND PROTECTION OF TRAFFIC	COST	10.0%		4,635,600
EROSION CONTROL AND POLLUTION PREVENTION (1%)	COST	1.0%		463,600
CONTRACTOR QUALITY CONTROL (2%)	COST	2.0%		927,200
CONSTRUCTION SURVEYING AND LAYOUT (2%)	COST	2.0%		927,200
Subtotal 2				**54,236,290**
MOBILIZATION (10%)	COST	10.0%		5,423,700
Subtotal 3				**59,659,990**
CONTINGENCIES		20.0%		11,932,000
CONSTRUCTION ENGINEERING		15.0%		8,949,000
INDIRECT COST ALLOWANCE (5.19%)		5.19%		3,096,353
Subtotal 4				**83,637,343**
DETAILED ESTIMATE				**83,637,000**
PCCP SMOOTHNESS INCENTIVE ($3,500/LANE MILE)	LANE MILE	12	$ 3,500.00	42,000
PCCP MATERIALS QUALITY INCENTIVE	SQ.YD.	145,301	$ 1.50	217,951
AR-ACFC PVMT SMOOTHNESS INCENTIVE ($11,000/LANE MILE)	LANE MILE	12	$ 11,000.00	132,000
PROJECT WIDE				**392,000**
FINAL DESIGN COSTS (10%)	COST	10.0%		8,363,700
RIGHT-OF-WAY (BOARD OF REGENTS)	ACRE	14.40	$ 200,000.00	2,880,000
RIGHT-OF-WAY (PREVIOUSLY DEDICATED TO COF)	ACRE	0.40	$ -	0
RIGHT-OF-WAY (PRIVATE OWNERSHIP)	ACRE	4.10	$ 200,000.00	820,000
UTILITY RELOCATIONS	L. SUM	1.00	$ 1,000,000.00	1,000,000
OTHER COSTS				**13,063,700**
DETAILED ESTIMATE				**83,637,000**
PROJECT WIDE				**392,000**
OTHER COSTS				**13,063,700**
TOTAL CONSTRUCTION COSTS				**97,100,000**

TABLE 17 – ESTIMATE OF PRELIMINARY CONSTRUCTION COST – BRAIDED UNDER ALTERNATIVE

Arizona Department of Transportation
Estimated Engineering Construction Cost
Itemized Estimate

Project Number: 040 CN 183 H758601C
Location: BELLEMONT TO WINONA
Version: Lone Tree TI
Alternative: Braided Under I-40

Braided Under I-40 Interchange Items

Item Description	Unit	Quantity	Unit Price	Amount
REMOVE FENCE	L.FT.	6,455	$ 2.00	$ 12,910.00
ROADWAY EXCAVATION	CU.YD.	579,031	$ 10.00	$ 5,790,310.00
AGGREGATE BASE, CLASS 2	CU.YD.	8,896	$ 30.00	$ 266,880.00
AGGREGATE SUBBASE (CLASS 6)	CU.YD.	960	$ 35.00	$ 33,600.00
BITUMINOUS TREATED BASE (6" PERMEABLE)	SQ.YD.	13,996	$ 12.00	$ 167,960.00
PORTLAND CEMENT CONCRETE PAVEMENT (10")	SQ.YD.	55,651	$ 50.00	$ 2,782,550.00
PORTLAND CEMENT CONCRETE PAVEMENT (14")	SQ.YD.	15,343	$ 58.00	$ 889,900.00
ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT RUBBER) (1")	TON	2,370	$ 45.00	$ 106,650.00
ASPHALT RUBBER MATERIAL (FOR AR-ACFC)	TON	226	$ 700.00	$ 158,200.00
MINERAL ADMIXTURE (FOR AR-ACFC)	TON	22	$ 90.00	$ 1,980.00
BRIDGE (NEW I-40 WESTBOUND NEW LONE TREE OP)	SQ. FT	19,476	$ 120.00	$ 2,337,120.00
BRIDGE (NEW I-40 EASTBOUND NEW LONE TREE OP)	SQ. FT	10,675	$ 120.00	$ 1,281,000.00
BRIDGE (NEW WB ENTRANCE RAMP)	SQ. FT	19,634	$ 120.00	$ 2,356,080.00
BRIDGE (NEW BRAIDED RAMP LONE TREE OP)	SQ. FT	8,641	$ 120.00	$ 1,036,920.00
BRIDGE (NEW I-40 WESTBOUND EXST LONE TREE OP)	SQ. FT	1,790	$ 120.00	$ 214,800.00
BRIDGE (NEW I-40 EASTBOUND EXST LONE TREE OP)	SQ. FT	4,737	$ 120.00	$ 568,440.00
RETAINING WALL	SQ. FT	51,000	$ 45.00	$ 2,295,000.00
DRAINAGE	L. SUM	1	$ 300,000.00	$ 300,000.00
PAVEMENT MARKING - YELLOW	L.FT.	11,250	$ 0.60	$ 6,750.00
PAVEMENT MARKING - WHITE	L.FT.	41,250	$ 0.60	$ 24,750.00
PAVEMENT MARKING - ARROWS & LEGEND	EACH	26	$ 75.00	$ 1,950.00
PAVEMENT MARKING - PAINT BULLNOSE	EACH	5	$ 50.00	$ 250.00
PAVEMENT MARKING - TYPE C RECESSED MARKERS	EACH	600	$ 5.00	$ 3,000.00
SIGNING - MAINLINE CATILEVER	EACH	4	$ 40,000.00	$ 160,000.00
SIGNING - SIGN BRIDGE	EACH	5	$ 80,000.00	$ 400,000.00
SIGNING - CROSSROAD BRIDGE	EACH	5	$ 28,000.00	$ 140,000.00
SIGNING - GUIDE SIGNS	EACH	9	$ 2,000.00	$ 18,000.00
SIGNING - REGULATORY, WARNING, OR MARKER	EACH	11	$ 1,000.00	$ 11,000.00
SIGNING - REGULATORY, WARNING, OR MARKER (DOUBLE)	EACH	11	$ 1,200.00	$ 13,200.00
TRAFFIC SIGNAL	EACH	2	$ 150,000.00	$ 300,000.00
LIGHTING - POLE ASSEMBLY	EACH	90	$ 5,000.00	$ 450,000.00
LIGHTING - ELECTRICAL DISTRIBUTION	L.FT.	22,500	$ 15.00	$ 337,500.00
LIGHTING - LOAD CENTER	EACH	1	$ 10,000.00	$ 10,000.00
LIGHTING - NEW ELECTRIC SERVICE	L.SUM	1	$ 10,000.00	$ 10,000.00
CHAIN LINK FENCE	L.FT.	7,760	$ 8.00	$ 62,080.00
GUARD RAIL, W-BEAM, TYPE 1	L.FT.	7,993	$ 20.00	$ 159,860.00
GUARD RAIL, END TERMINAL ASSEMBLY	EACH	4	$ 3,000.00	$ 12,000.00
CONCRETE CURB AND GUTTER	L.FT.	2,000	$ 20.00	$ 40,000.00
CONCRETE SINGLE CURB	L.FT.	1,000	$ 20.00	$ 20,000.00
CONCRETE SIDEWALK	SQ. FT.	8,400	$ 5.00	$ 42,000.00
Braided Under I-40 Interchange Items	**DETAILED ESTIMATE SUBTOTAL**			**22,741,830**

I-40 Mainline Widening Items

Item Description	Unit	Quantity	Unit Price	Amount
REMOVE EXISTING CONCRETE MEDIAN BARRIER	L.FT.	1,762	$ 4.50	$ 7,930.00
REMOVAL OF ASPHALTIC CONCRETE PAVEMENT	SQ YD	85,505	$ 2.50	$ 213,770.00
REMOVAL OF STRUCTURES AND OBSTRUCTIONS	L.SUM	1	$ 25,000.00	$ 25,000.00
REMOVE BITUMINOUS PAVEMENT (MILLING) (1")	SQ.YD.	17,078	$ 1.50	$ 25,620.00
CLEARING AND GRUBBING	ACRE	25	$ 2,000.00	$ 50,000.00
ROADWAY EXCAVATION	CU.YD.	261,517	$ 10.00	$ 2,615,170.00
AGGREGATE BASE, CLASS 2	CU.YD.	21,836	$ 30.00	$ 655,080.00
AGGREGATE SUBBASE (CLASS 6)	CY	6,100	$ 35.00	$ 213,500.00
BITUMINOUS TREATED BASE (6" PERMEABLE)	SQ.YD.	128,187	$ 12.00	$ 1,538,250.00
PORTLAND CEMENT CONCRETE PAVEMENT (14" DOWELED)	SQ.YD.	67,413	$ 60.00	$ 4,044,780.00
PORTLAND CEMENT CONCRETE PAVEMENT (14")	SQ.YD.	60,775	$ 58.00	$ 3,524,950.00
LOAD TRANSFER DOWEL ASSEMBLY (12-FT)	EACH	3,478	$ 110.00	$ 382,580.00
ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT RUBBER) (1")	TON	7,716	$ 45.00	$ 347,220.00
ASPHALT RUBBER MATERIAL (FOR AR-ACFC)	TON	733	$ 700.00	$ 513,100.00
MINERAL ADMIXTURE (FOR AR-ACFC)	TON	70	$ 90.00	$ 6,300.00
BRIDGE (NEW I-40 WESTBOUND EXST LONE TREE OP)	SQ. FT	8,168	$ 120.00	$ 980,160.00
BRIDGE (NEW I-40 EASTBOUND EXST LONE TREE OP)	SQ. FT	7,028	$ 120.00	$ 843,360.00
DRAINAGE	L. SUM	1	$ 100,000.00	$ 100,000.00
PAVEMENT MARKING - YELLOW	L.FT.	30,938	$ 0.60	$ 18,570.00
PAVEMENT MARKING - WHITE	L.FT.	46,407	$ 0.60	$ 27,850.00
ITS - LANDLINE SYSTEM	L.FT.	10,350	$ 75.00	$ 776,250.00
ITS - DETECTION STATIONS	EACH	4	$ 20,000.00	$ 80,000.00
SIGNING - MILE POST MARKERS	EACH	4	$ 250.00	$ 1,000.00
SIGNING - GUIDE SIGNS	EACH	1	$ 2,000.00	$ 2,000.00
SIGNING - REGULATORY, WARNING, OR MARKER	EACH	2	$ 1,000.00	$ 2,000.00
SEEDING (CLASS II)	ACRE	15	$ 2,800.00	$ 42,000.00
GUARD RAIL, W-BEAM, TYPE 1	L.FT.	8,202	$ 20.00	$ 164,040.00
GUARD RAIL, END TERMINAL ASSEMBLY	EACH	12	$ 3,000.00	$ 36,000.00
CONCRETE BARRIER (C10.99)	L.FT.	1,762	$ 80.00	$ 140,960.00
NOISE BARRIER WALL	SQ.FT.	24,053	$ 33.00	$ 793,750.00
I-40 Mainline Widening Items	**DETAILED ESTIMATE SUBTOTAL**			**18,171,190**

Arizona Department of Transportation
Estimated Engineering Construction Cost
Itemized Estimate

Project Number: 040 CN 183 H758601C
Location: BELLEMONT TO WINONA
Version: Lone Tree TI
Alternative: Braided Under I-40

COMBINED DETAILED ESTIMATE SUBTOTAL				**40,913,020**
MISCELLANEOUS WORK (15%)	COST	15.0%		6,137,000
Subtotal 1				**47,050,020**
DUST PALLIATIVE (1%)	COST	1.0%		470,600
FURNISH WATER (1%)	COST	1.0%		470,600
MAINTENANCE AND PROTECTION OF TRAFFIC	COST	10.0%		4,705,100
EROSION CONTROL AND POLLUTION PREVENTION (1%)	COST	1.0%		470,600
CONTRACTOR QUALITY CONTROL (2%)	COST	2.0%		941,100
CONSTRUCTION SURVEYING AND LAYOUT (2%)	COST	2.0%		941,100
Subtotal 2				**55,049,120**
MOBILIZATION (10%)	COST	10.0%		5,505,000
Subtotal 3				**60,554,120**
CONTINGENCIES		20.0%		12,110,900
CONSTRUCTION ENGINEERING		15.0%		9,083,200
INDIRECT COST ALLOWANCE (5.19%)		5.19%		3,142,759
Subtotal 4				**84,890,979**
DETAILED ESTIMATE				**84,891,000**
PCCP SMOOTHNESS INCENTIVE ($3,500/LANE MILE)	LANE MILE	12	$ 3,500.00	42,000
PCCP MATERIALS QUALITY INCENTIVE	SQ.YD.	142,183	$ 1.50	213,274
AR-ACFC PVMT SMOOTHNESS INCENTIVE ($11,000/LANE MILE)	LANE MILE	12	$ 11,000.00	132,000
PROJECT WIDE				**387,000**
FINAL DESIGN COSTS (10%)	COST	10.0%		8,489,100
RIGHT-OF-WAY (BOARD OF REGENTS)	ACRE	17.10	$ 200,000.00	3,420,000
RIGHT-OF-WAY (PREVIOUSLY DEDICATED TO COF)	ACRE	0.40	$ -	0
RIGHT-OF-WAY (PRIVATE OWNERSHIP)	ACRE	2.40	$ 200,000.00	480,000
UTILITY RELOCATIONS	L. SUM	1.00	$ 1,000,000.00	1,000,000
OTHER COSTS				**13,389,100**

DETAILED ESTIMATE	**84,891,000**
PROJECT WIDE	**387,000**
OTHER COSTS	**13,389,100**
TOTAL CONSTRUCTION COSTS	**98,700,000**